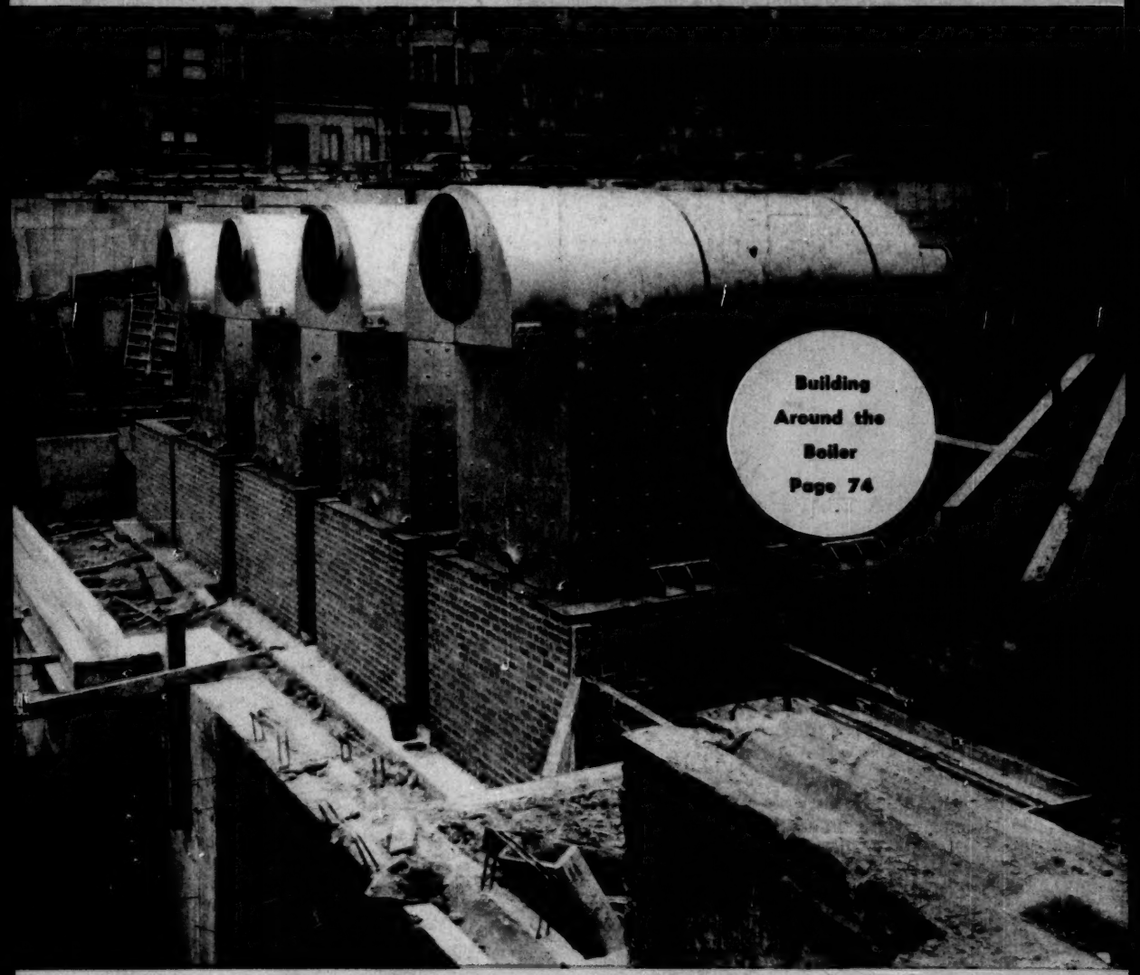
DECEMBER, 1951

HEATING AND VENTILATING

INCLUDING AIR CONDITIONING – PIPING – REFRIGERATION – AIR SANITATION



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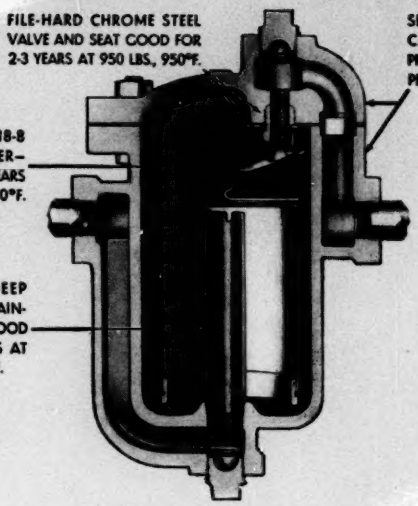
HOW LONG WILL THIS TRAP LAST AT 1 TO 15 LBS. PRESSURE?


FILE-HARD CHROME STEEL VALVE AND SEAT GOOD FOR 2-3 YEARS AT 950 LBS., 950°F.
SEMI-STEEL BODY AND CAP. 250 LBS. DESIGN PRESSURE, 1500 LBS. TEST PRESSURE
EXTRA STRONG 18-8 STAINLESS LEVER—GOOD FOR 2-3 YEARS AT 950 LBS., 950°F.
WELDED OR DEEP DRAWN 18-8 STAINLESS BUCKET—GOOD FOR 5-10 YEARS AT 950 LBS., 950°F.

● *Left*—No. 800 trap with opposite and horizontal connections. ½" or ¾" connections. $10.00 list.

● *Right*—No. 801 trap with right angle connections. ½" or ¾". $10.00 list.

● *Left*—No. 880 trap with built-in strainer, saves time, labor and fittings. ½" or ¾". Only $11.50 list complete.

HERE'S A TRAP mechanism for low pressures that is identical in design, materials and workmanship to that used in traps for pressures to 950 lbs., temperatures to 900°F.* You know that it will last a LONG TIME with an absolute minimum of maintenance on a low pressure heating system.

Users report: "4 to 5 years without service"..."10 years—no repairs"... "30% to 50% less maintenance."

Add to the high quality, low maintenance features of this trap the following benefits: large air handling capacity (blast buckets with auxiliary thermic vents where you need them)... self-scrubbing action... immunity to corrosion... ease of installation—and you have an unbeatable trap for any heating job.

Call your nearby Armstrong Representative for details and prices.

ARMSTRONG MACHINE WORKS

846 Maple Street, Three Rivers, Michigan

**Mass production of traps for all pressures makes it possible to deliver this mechanism at no premium in price.*

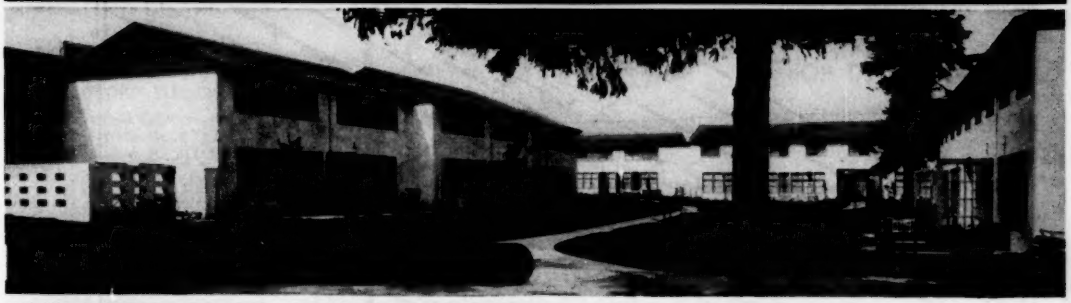
SEND FOR CATALOG...

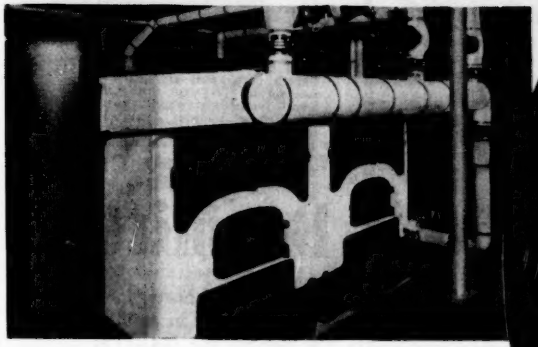
The Armstrong Steam Trap Book gives complete catalog information on Armstrong traps, explains trap selection and installation. You are welcome to a copy.

ARMSTRONG STEAM TRAPS

AMERICAN-Standard

First in heating...first in plumbing





13 AMERICAN-Standard WATER TUBE BOILERS heat 276 unit project

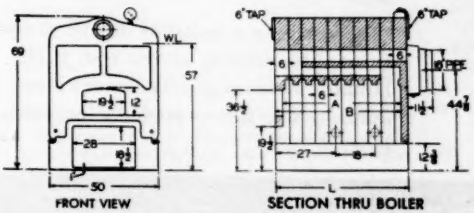
● One of the Northwest's finest court-type housing projects is Portland's attractive Binford. Privately owned by Mr. L. C. Binford, this 276 unit residential community is as modern as you'll find anywhere. And, of course, American-Standard products play an important role in keeping it so!

The entire heating system of this large project is dependably fired by 13 oil fired No. 36 Water Tube Boilers. Installed in most instances in batteries of two, they are doing an efficient, economical job of keeping all units in this many-family community snugly warm and comfortable.

The selection of American-Standard heating equipment for this development is just another example of the tremendous preference that exists among builders, owners, architects and engineers for all products bearing the famous American-Standard name.

These boilers and other top quality heating equipment by American-Standard are sold through selected wholesale distributors to heating and plumbing contractors. **American Radiator & Standard Sanitary Corporation,** P. O. Box 1226, Pittsburgh 30, Pa.

LOOK FOR THIS MARK OF MERIT



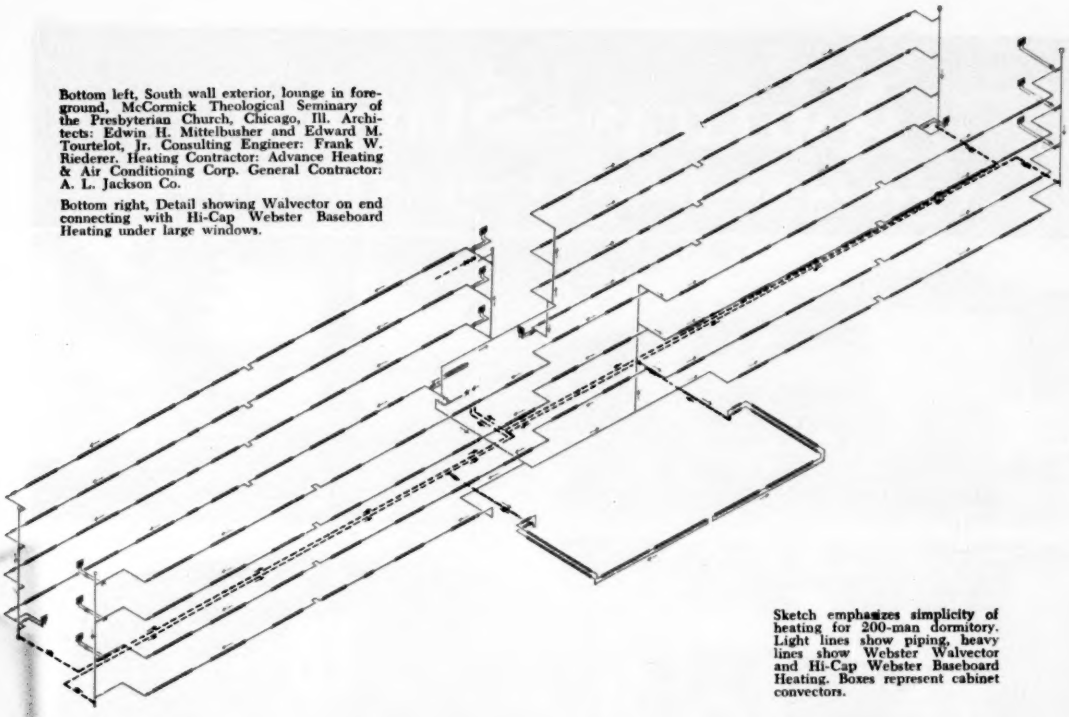
American-Standard Water Tube Boilers are made in a wide range of sizes so that, either single or in battery, they meet the heating requirements of any type of building. The diagrams above are front and sectional views of No. 36 Water Tube Boiler. In the sectional diagram, dimensions indicated are: (A)—from 29½" to 65½". (B)—32¾" to 68¾". (L)—36" to 72".

Serving home and industry

AMERICAN-STANDARD · AMERICAN BLOWER · CHURCH SEATS · DETROIT LUBRICATOR · KEWANEE BOILERS · ROSS HEATER · TONAWANDA IRON

Bottom left, South wall exterior, lounge in foreground, McCormick Theological Seminary of the Presbyterian Church, Chicago, Ill. Architects: Edwin H. Mittelbusher and Edward M. Tourtelot, Jr. Consulting Engineer: Frank W. Riederer. Heating Contractor: Advance Heating & Air Conditioning Corp. General Contractor: A. L. Jackson Co.

Bottom right, Detail showing Walvector on end connecting with Hi-Cap Webster Baseboard Heating under large windows.



Sketch emphasizes simplicity of heating for 200-man dormitory. Light lines show piping, heavy lines show Webster Walvector and Hi-Cap Webster Baseboard Heating. Boxes represent cabinet convectors.

Perimeter Heating for a Dormitory

True perimeter forced hot water Webster Heating was provided for the new dormitory building at McCormick Theological Seminary.

Continuous Heating Elements connected in series blanket the windows . . . spread the heat uniformly on every floor.

Consulting Engineer Frank W. Riederer says:

"The continuous radiation design contributed to economy of first cost. It eliminates exposed piping, leaves more usable room space, produces uniform heating.

"Steam from the Seminary's central heating plant is converted to hot water in a heat exchanger. In this design, the hot water system proved less expensive and more satisfactory than a system using steam."

Call the Authorized Webster Factory Representative or write us for his name.

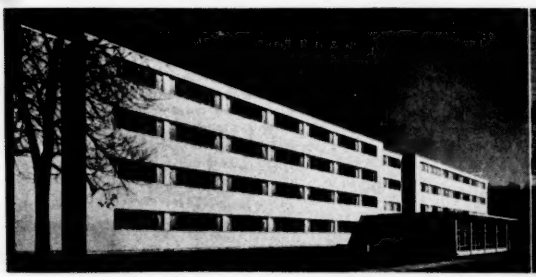
Address Dept. HV-12

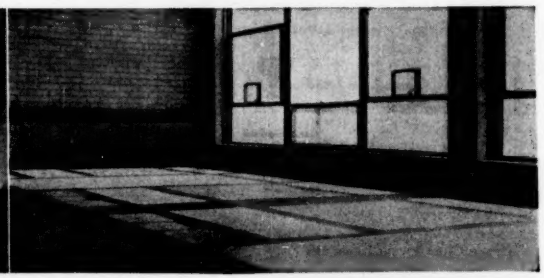
WARREN WEBSTER & COMPANY

Camden 5, N.J. Representatives in Principal U.S. Cities
In Canada, Darling Brothers, Limited, Montreal

Webster WALVECTOR
REG. U. S. PAT. OFF.

For Steam or Hot Water Heating





HEATING AND VENTILATING

A MONTHLY MAGAZINE FOR ENGINEERS AND CONTRACTORS CONCERNED WITH THE DESIGN AND APPLICATION OF AIR CONDITIONING, REFRIGERATION, PIPING, AIR SANITATION, HEATING AND VENTILATION IN BUILDINGS

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Also Publishers of
HEATING & PLUMBING EQUIPMENT NEWS
and technical books.

THIS MONTH'S COVER

A housing project of 2,220 rooms was erected on the site of the famous Schwab mansion at 11 Riverside Dr., New York City. Four boilers of 304 hp each were installed before the superstructure was erected. Photograph, courtesy of Fitzgibbons Boiler Co., Inc.

Washington News

LORING F. OVERMAN

HOW "butter" is to rank with "guns" as the nation goes into 1952 is subtly revealed in a single line of a recent Defense Production Administration announcement of allotments of structural steel for the first quarter of 1952. The line reads as follows:

Department of Agriculture—stated requirements 45,962 tons; allotment 4,000 tons; percentage 8.7.

The Department of Agriculture is the claimant agency responsible for requesting and distributing controlled materials required by the producers and processors of the nation's food products. The current distribution of structural steel leaves little doubt that few food products plants will be constructed. The 8.7% allowance is the lowest of 22 designations to claimant agencies, the next lowest being the 27.9% allocation given the Bureau of Public Roads.

And just as the allocation list points away from the food processing industries, it also reveals where the heating, ventilating, and air conditioning industry may look for business as the months pass. Following are some of the more generous allocations, expressed in percentages granted in comparison with amounts requested:

Department of the Army, for Domestic Construction 76.9; Atomic Energy Commission 99.9; Department of Defense 88.9; Defense Electric Power Administration 77.1; Defense Minerals Administration 80.9; Defense Solid Fuels (coke ovens) 80.4; Defense Transport Administration 48.9; General Services Administration 65.5; Department of the Interior 80.4; Petroleum Administration for Defense 76.5; Federal Security Agency for schools 48.1, and for hospitals 58.8

A further tip-off lies in percentage (of request) allocations to National Production Authority Industry Divisions. In part, they are as follows:

Building materials division 76.1; Communications division 67.7; Facilities and Construction Bureau 62.9; General Industrial Equipment Division (including heating, ventilating and air conditioning), 85.2; Engine and Turbine Division 96.2; Iron and Steel Division 52.9; Metalworking Machinery and Equipment 70.7; Miscellaneous Metals and Minerals 86.3; Ordnance and Shipbuilding 51.9; Railroad Equipment Division 60.8; Textile Equipment 78.3, and Water Resources 43.1.

Out of an estimated supply of 1,425,000 tons, structural steel authorized for construction during the first three months of 1952 totalled about 800,000 tons—about the same as during the fourth quarter of 1951. The screened, stated requirements of all DPA claimant agencies added up to more than 200% of available supplied. DPA officials point out, however, that in cutting requests in half, some are still far higher than normal.

Considering, for example, the Federal Security Administration program for schools, hospitals and other educational construction, we find that an allocation of 61,000 tons for the quarter permits a rather substantial program. It will support the 1,400 elementary and secondary school projects now under way; will permit some 300 new starts, and will meet half the requirements for a requested 600 libraries, museums and institutions of higher education.

As for hospitals under the Federal Security Agency program, there is to be sufficient materials to continue construction of all under way, but comparatively little for new construction.

Near Ceiling

A recent conference between NPA construction officials and business paper editors revealed that proposed expansion programs in the steel industry are not expected to boost the supply of structural steel to any marked extent.

Spokesmen for DPA explain that structural shapes and their production is a complicated subject. "First of all," they report, "you have to have a mill designed to produce the shapes. Second, you have to have very intricate equipment, primarily in the form of rolls. The investment is terrific, but if you don't have the mill, if you don't have the rolls, you could have steel coming out of your ears and you couldn't get a pound more of structural shapes."

There is also the question of manpower. "You don't just hire a man out of a sheet mill, for example, and put him to work on structural shapes. He has to go through a lengthy training period. Because of the manpower factor, it is most difficult to add a shift to present mills, or even to consider new capacity for making structural shapes.

Construction Rules

In addition to saying how much construction steel and other scarce materials may be acquired, the Controlled Materials Plan sets definite rules for its use. In general, the CMP plan recognizes four classes of construction, each with its own set of ground rules.

The first classification includes recreational, entertainment and amusement structures. When the first CMP version came out August 3—and there has been little change since then—the planners said that no one could commence construction of such buildings if more than two tons of steel and 200 pounds of copper would be required. The regulations required also that, after October 1, no one could continue construction of such buildings if he expected to use for the completion of his job more than two tons of steel and 200 pounds of copper.

The second classification involves residential construction, with the Housing and Home Finance Agency administering. Rules established by HHFA specify the quantities of scarce materials that may be used and self-authorized. Direction 1 to CMP Regulation 6 specifies the quantities of materials that may be self-authorized for 1, 2, 3 and 4-family houses.

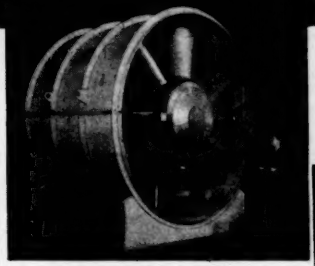
Multi-unit construction, which is now considered as apartment construction to all intents and purposes, requires permission of HHFA, following approval of a CMP 4-C application, and procurement of an allotment.

The third type of construction is industrial. In this classification, CMP administrators recognize that a great deal of essential industrial construction is relatively small. Therefore, the order specifies that users can self-authorize their procurement of controlled materials for industrial building, expansion, or alteration under stated conditions.

Write

No. 3181-B No. 3533-C No. 3737 No. 3703

"Buffalo" FANS

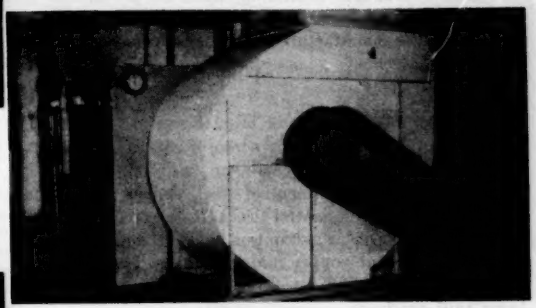


LIMIT-LOAD ▸

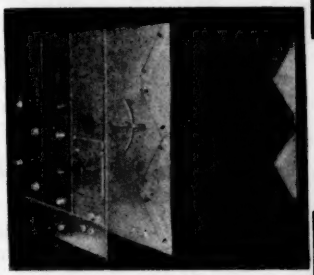
The fans with the complete size selection—600 cfm to over half a million cfm—to match almost any ventilating or air conditioning requirement, they are non-overloading regardless of system pressure. Double backward curved blades, specially shaped housing scroll and inlet guide vanes make for unusually quiet, efficient delivery. WRITE FOR BULLETIN 3737.

◂ **AXIAL FLOW**

Like the Limit-Load Fans, this design is popular for ventilating and air conditioning work. Also non-overloading. Axial Flows are suited to duct mounting as booster fans, with hood and vat exhaust systems, with roof exhausts, etc. They are compact and light in weight. Shown is a specially large model in stainless steel built for a customer. BULLETIN 3533-C ON REQUEST.



"Buffalo" AIR CONDITIONING UNITS

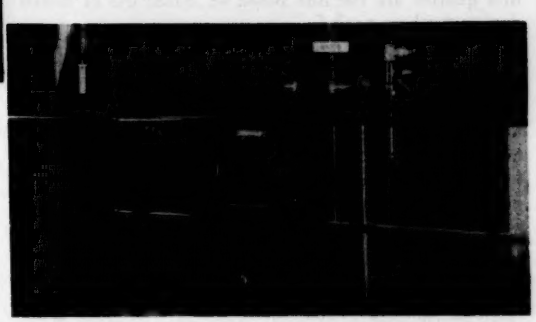


AIR WASHERS ▸

Used throughout industry for the past fifty years, "Buffalo" Air Washers are efficient, reliable units doing a hundred and one comfort, quality control and health jobs—removing dust, dirt and bacteria from the air as well as cooling and humidifying. A wide range of types and capacities—described in BULLETIN 3181-B. Write for your copy!

◂ **PC CABINETS**

These space-saving central air conditioning cabinets are quality-built in all parts to do a thorough, satisfactory job. Easy on installation and maintenance, they are available in vertical (VPC) or horizontal models, for any desired air conditioning functions—humidity control, air cleaning, heating, cooling. For all data on the model for your job, request BULLETIN 3703.



FIRST FOR FANS

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VENTILATING FORCED DRAFT | AIR WASHING COOLING | AIR TEMPERING HEATING | INDUCED DRAFT EXHAUSTING PRESSURE BLOWING

Such builders may procure by self-authorization as much as 25 tons of steel per quarter; 2,000 pounds of copper and 1,000 pounds of aluminum.

Another type of construction is labeled as "all other." It includes commercial building, schools, hospitals and all other types. In this classification a builder may start construction and self-authorize the purchase of not more than two tons of steel and 200 pounds of copper per project per quarter. Construction which can be strung out over one or more quarters may use materials self-authorized in subsequent quarters.

The restrictions on the use of copper and aluminum apply only to the primary shapes—not to such materials incorporated into finished, or "B" products. For example, an aluminum window is a "B" product. If a builder can purchase an aluminum window from his supplier, he may use it without charging it against his allowable total of aluminum. Similarly, copper products may be acquired in finished form. The limitations upon the production of such finished products have, presumably, already been applied to the manufacturer of the product themselves.

Hard Goods Cut

Just how long a builder or other buyer will be able to find hard goods is becoming a real question. In the distribution of first quarter metals, an essentiality ruling is being followed for allotment of steel, copper and aluminum. The relatively essential products are receiving 50% of their base period consumption of steel, and 35% of a base period use of copper and aluminum. Less essential uses are assigned 50% steel, 20% aluminum and 10% brass mill products.

Under the current National Production Authority plan, every producer will get something, and applications will be considered for supplemental allotments of steel if the manufacturer can show where steel was substituted for copper and aluminum. Allotments just announced for the first quarter are the first based on actual use of metals during the base period.

Gas Ban Modified

The Petroleum Administration for Defense has modified its natural gas restriction Order No. 2 to permit extension of service to house-heating customers served by four companies in Michigan, two in New York, and one in New Jersey. As originally issued in August, the order was designed to slow down expansion of natural gas services in areas where a gas shortage threatens this winter. Purpose of the order was to maintain service for customers already dependent upon natural gas, and to assure adequate supplies for defense industries. The order is applicable in Connecticut, Delaware, District of Columbia, parts of Kentucky, Massachusetts, Michigan, New Jersey, New York and Rhode Island. Public regulatory bodies in Maryland, New Hampshire, Ohio, Pennsylvania, Virginia, West Virginia and Wisconsin have taken over distribution responsibilities, thereby exempting their states from the regulation.

The Petroleum Administration for Defense has also announced that it has turned down 14 applications from Massachusetts companies on the ground that the order itself, in permitting new space heating customers to be added yearly to the extent of 5% of the number of customers served at the time the order became effective, gave sufficient leeway for normal expansion. In modifying the order for the specified areas of Michigan, New York and New Jersey, it was found that sufficient supplies of natural gas were available to supply the added customers without endangering the defense effort.

Synthetics Studied

An independent study seeking an acceptable engineering and financial bases for estimating cost of synthetic fuel products of commercial-size coal hydrogenation plants has been approved by Secretary of the Interior Oscar L. Chapman. The new study, requested by the Bureau of Mines, follows a similar report by the National Petroleum Council showing substantially higher costs than those compiled by the Bureau.

Impact Explained

Why the military program, reputedly taking only 10 to 20% of available steel, puts such a crimp in civilian production programs, has been explained by Munitions Board Chairman John D. Small. He said that while the direct military take of steel now amounts to only a little more than 10% of the total, the demand for some forms and shapes is much higher.

Mr. Small said that much of the current shortage of steel stems from the heavy impact of the industrial expansion program, including both actual construction and machinery and equipment. He felt that the steel shortage would gradually clear up by early 1953, when new steel production is due.

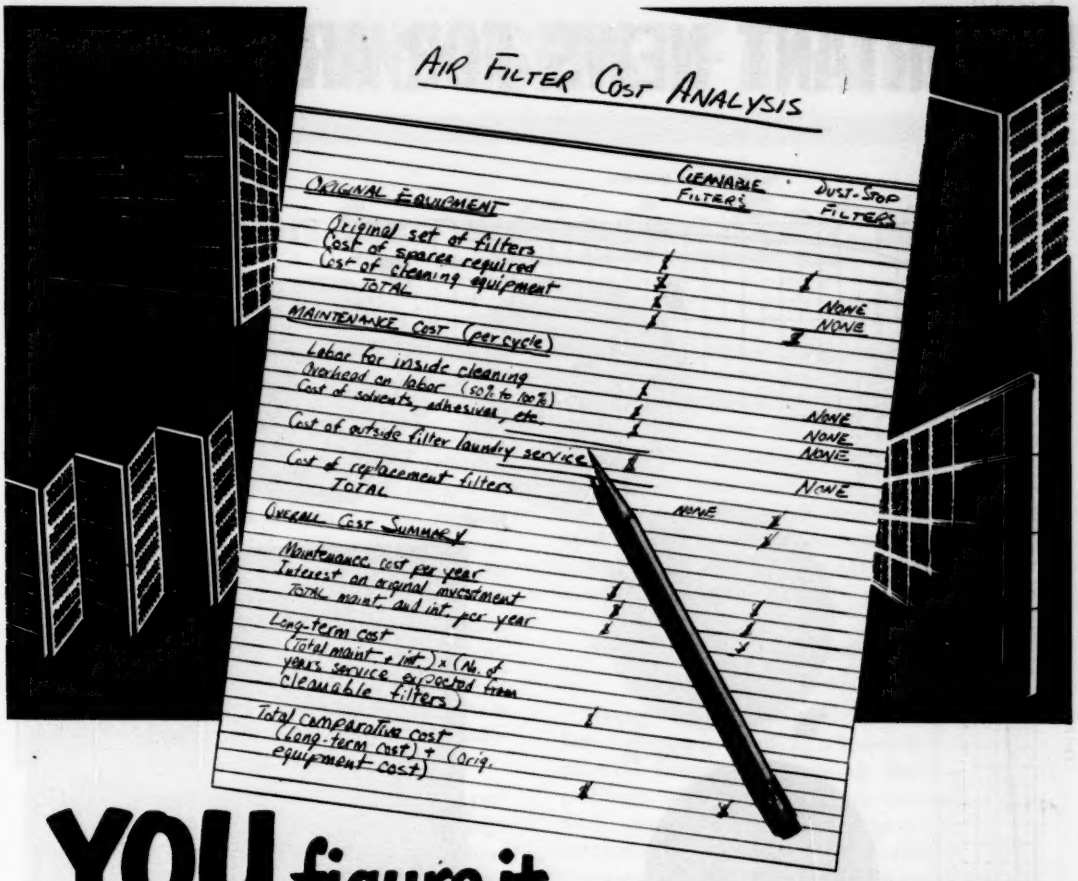
Copper, however, presents a difficult problem, he said. Domestic supply is going down with the depletion of the mines, and copper "is very scarce and growing scarcer," Mr. Small said. The direct military take for the first quarter will be between 40 and 42%, with a large percentage going into ordnance.

Oil Drilling Allotments

Mr. Small estimated the military take of aluminum at 45% for the first quarter. He said the supply picture for the next six months will be very bad, but that new production will come in during the fall of 1952.

In alloting tubular goods to 1,855 domestic oil and gas producers for the first quarter of 1952, the Petroleum Administration for Defense has made public the standards it used in distributing the supplies. The standards provide for two types of allotments. One is an emergency allotment for wildcat operators, under which 5% of the available casing, tubing and drill pipe is set aside in field stocks. The other is an allotment for regular drilling operations. This second allotment is further broken down into amounts for primary and supplemental authorizations. The primary allotment includes 75% of all casing and tubing, and 90% of all drill pipe.

The primary allotment is then divided equitably between Class A and B operators on the basis of their previous drilling history. Class A operators are those that have drilled 40 or fewer wells in the four quarters preceding the quarter in which the application is made. Class B operators are those that drilled over 40 wells in the four quarters. In distributing emergency allotments, top priority will go to wildcat wells—those drilled in an effort to find new fields.



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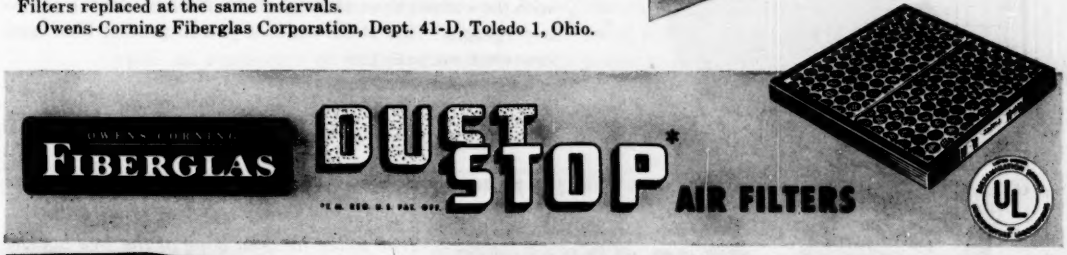
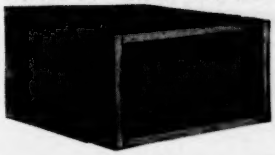
You see, while rising labor costs have made filter cleaning more expensive, mass production has lowered the cost of Dust-Stop Filters. In fact, on the basis of one 40c cleaning every 90 days, cleanable filters would have to last up to 14 years to match the cost of Dust-Stop Filters replaced at the same intervals.

Owens-Corning Fiberglas Corporation, Dept. 41-D, Toledo 1, Ohio.

The "Comparative Study of Air Filtering Costs" contains facts, figures, and charts important to anyone interested in air conditioning. A copy free on request. Write today.





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Ageless, light in weight, firesafe, moisture resistant, Fiberglas Duct Insulations can be easily applied . . . have very high acoustical value . . . won't erode at 6,000 fpm . . . cost less than other insulations approaching them in thermal efficiency. Write for details.

*DUST-STOP is the trade-mark of Owens-Corning Fiberglas Corporation for impingement-type air filters made of glass fibers. FIBERGLAS is the trade-mark (Reg. U. S. Pat. Off.) of Owens-Corning Fiberglas Corporation for a variety of products made of or with fibers of glass.

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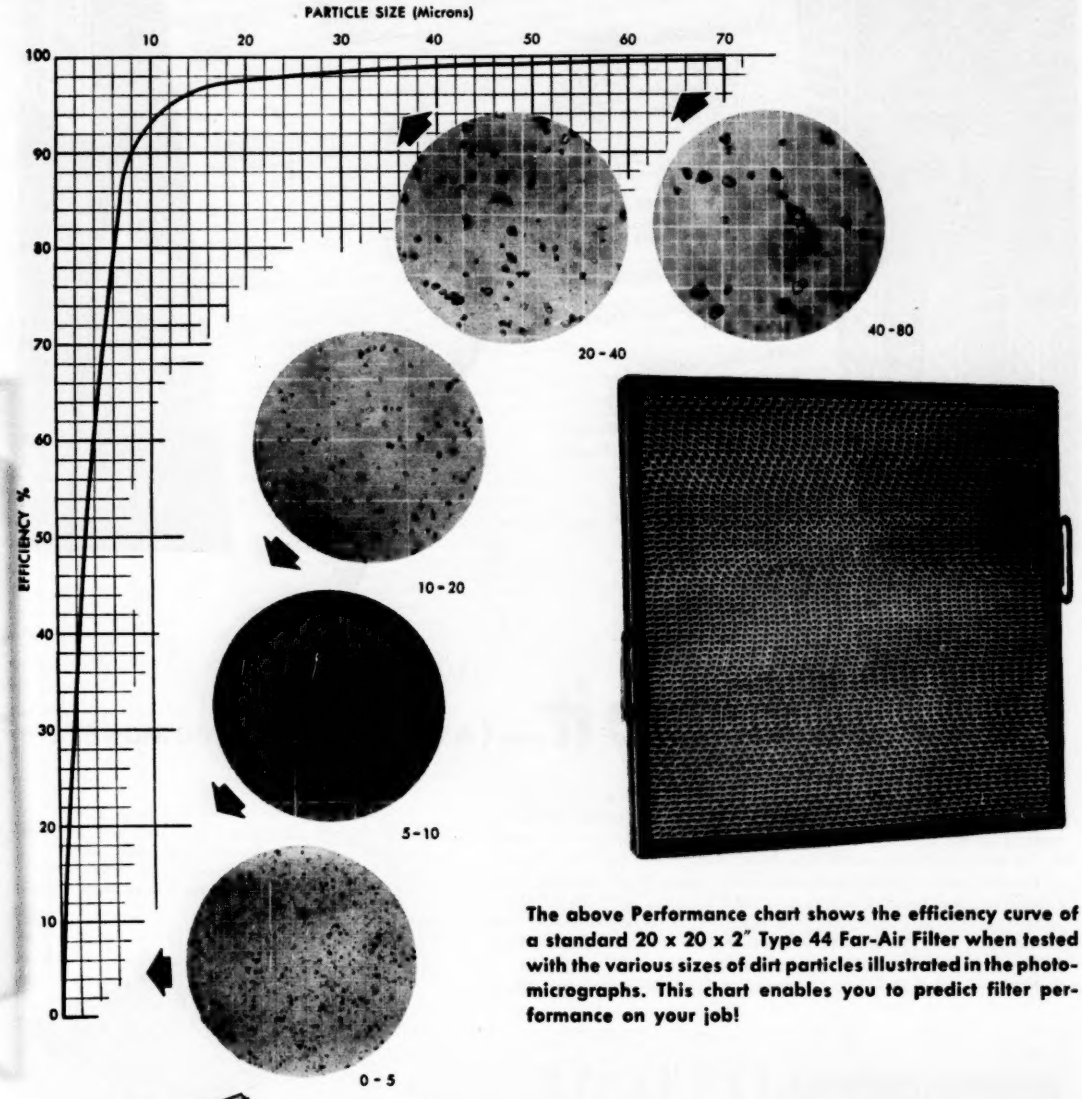


The above Performance chart shows the efficiency curve of a standard 20 x 20 x 2" Type 44 Far-Air Filter when tested with the various sizes of dirt particles illustrated in the photo-micrographs. This chart enables you to predict filter performance on your job!

FREE BOOKLET

Write today for your copy of the free booklet on the Farr testing procedures. This gives full technical information on the equipment used in these tests and the results obtained. Address: Farr Company P.O. Box 10187 Airport Station, Los Angeles 45, California.

ENGINEERS AND USERS OF AIR FILTERS

FAR-AIR* Offers You *Performance Rated* Air Filters

Greatly Improved Testing Methods Take the Guesswork Out of Air Filtration

Farr engineers, after years of research, have developed an improved method of measuring filter efficiencies. New applications of apparatus assure uniformity of air flow, dust feed rate, and sampling of the dust laden air ahead of and after the test filter. Improved test duct design has accomplished thorough dust dispersion and uniform dust distribution. Using test dusts of known chemical and particle size analyses in this equipment gives a more accurate evaluation of filter performance.

The reason for this change in testing procedures is the fact that all architects, engineers and reputable filter manufacturers know this important fact about air filters: *no filter—regardless of its design—operates at equal efficiency under all dust conditions.* For example, a filter may stop "gravel" with 100% efficiency, but may have 1% efficiency when exposed to dust particles of 0 to 5 micron size. (1 micron = 1/25,000 inch)

Filter Buyers Know This, Too...

Each user of air filtration equipment requires a different filter efficiency. For example, an electronics or watch manufacturer must have even the finest dust particles removed and knows he should buy the necessarily more expensive air filtering equipment to accomplish this. A department store, however, may not require the removal of ultra fine particles. By using the type filter which meets the efficiency requirements of the job, costs can be reduced. This is the reasoning behind FAR-AIR *Performance Rated* air filters.

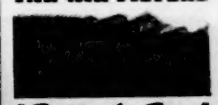
Here's How FAR-AIR Know-How Can Help You

Through research and field experience Farr Company has built up a knowledge of practical solutions to many air filtration problems. These problems have involved many types of dusts in a wide range of concentrations and under varied conditions. Recommendations of our field service engineers can be of valuable assistance in helping you to properly solve your air filtration problems.

Farr Company Offers

full information on this radically improved filter testing procedure to all industries and filter manufacturers to further enhance the reputation of the air filtration industry as a source of reliably applicable information on its products.

FAR-AIR FILTERS



"Better by Farr"

*Trade Mark Reg.

FARR COMPANY *Manufacturing Engineers*

Los Angeles • Chicago • New York

Mf'd under license by Control Equipment Co. Ltd., Montreal, Canada

WOULD YOU PLAY A TOURNAMENT *with one club?*

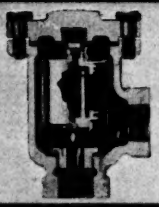
But on the golf course you can see the results. In steam hook-ups on the other hand, bad performance may go undetected for years, even though the traps apparently are working properly.

If you are in competition, it is certain that you cannot get the lowest fuel costs and highest production rates from steam heating and process equipment by "standardizing" on one type of steam trap for all purposes in your plant.

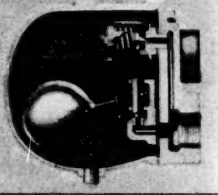
The four principal types of Sarco steam traps are illustrated at the right. They are available in a wide range of sizes and steam pressures and each has a specific function. The trick is to get the right trap on every steam job and every steam line in your plant. This can be done by calling in the Sarco Representative near you, or by asking for Sarco Catalog No. 1600 which gives recommendations for trapping all kinds of equipment, both indoors and out.

STEAM TRAPS ARE LIKE THAT...

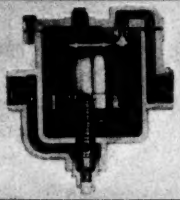
Thermostatic Trap



Float-Thermostatic Trap



Bucket Trap



Liquid Expansion Trap

312

SARCO SAVES STEAM

IMPROVES PRODUCT QUALITY AND OUTPUT

SARCO COMPANY, INC.

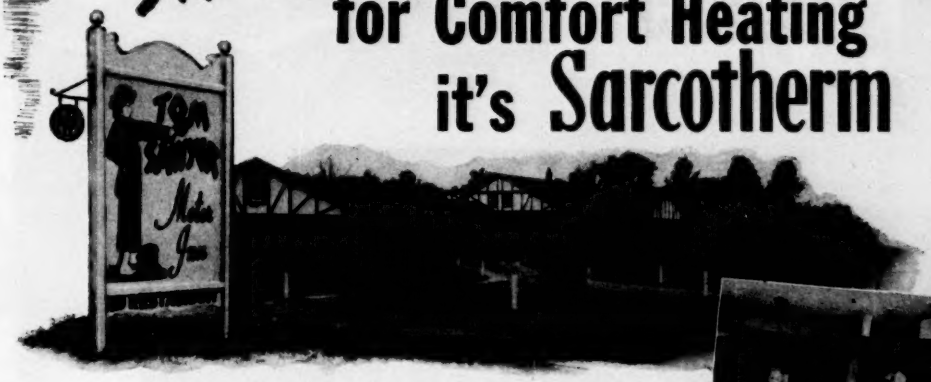
Represented in Principal Cities

Empire State Building, New York 1, N. Y.

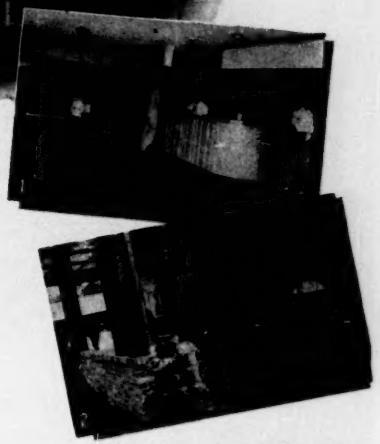
SARCO CANADA, LTD., TORONTO 5, ONTARIO

In Motor Courts too!

for Comfort Heating it's Sarcotherm



Tom Sawyer Motor Inn, Albany, N. Y., 100 rooms with 100 baths. Highly rated by A.A.A. Radiant Heating System, designed and installed by LeVally-McLeod, Inc. of Albany, includes 5 zones—completely Sarcotherm equipped.



1. Main Lobby and Registration Desk at Tom Sawyer Motor Inn.
2. Friends meet at the main entrance in the atmosphere of an exclusive country club.

Today the luxurious motels which are rapidly displacing the old overnight cabins along our highways from coast to coast, include central heat among the hotel comforts offered.

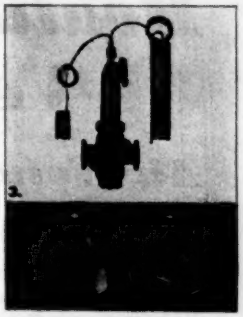
Heating of the one-story, spread-out buildings is usually by forced hot water or radiant means, for which

SARCOTHERM

weather-compensated temperature control with continuous circulation is unequalled.

We have pioneered in this field and our experience is at the disposal of architects and engineers who are designing motor courts and wish to include the latest in automatic heating. Here are a few of the Motels recently equipped with Sarcotherm Controls:

Newberry Motel, Russelville, Ky.
Miami Courts Tourist Cabins, Salisbury, Md.
Hotel Sleep, Rahway, N. J.
Garden Motor Lodge, Troy Hills, N. J.
Dutch Maid Motor Lodge No. 2, Woodbridge, N. J.
Smith's Tourist Court, R.F.D., Lynchburg, Va.
Van Winkle Motel, Everett, Washington
Snyder's Court, North Bend, Washington
Leonard Auto Court, Parkland, Washington



3. The heart of the Sarcotherm control system for radiant or forced hot water heating is this unique control valve. It is actuated by liquid expansion thermostats, one located outside the building and one in the valve itself. Between them they anticipate changes in heat loss ratio, thus maintaining comfort temperatures under all conditions.

4. The Sarcotherm Comfort Control "Thermoray" is an extremely sensitive thermostat affected by both radiation and convection.

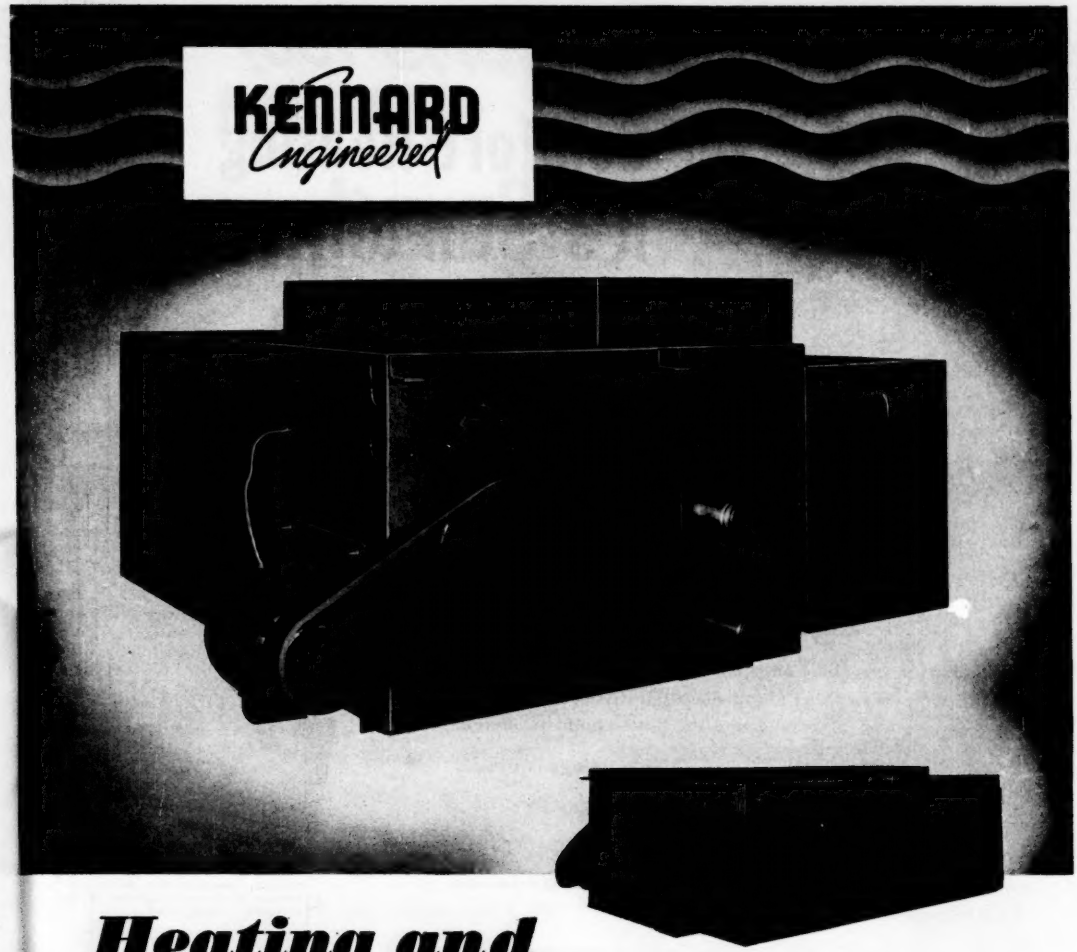
SARCOTHERM CONTROLS, INC.

Empire State Bldg., New York 1, N. Y. • Represented in principal cities

A SARCO PRODUCT

23

KENNARD Engineered



Heating and Ventilating Units

Air Volumes from 400 to 21,000 CFM

Kennard Heating and Ventilating Units are the answer to requirements of heating and filtering recirculated air, fresh air, a mixture of both, or for ventilation only. These ruggedly constructed and easily installed units, conventionally used for heating large spaces or as a central station unit to heat many small rooms, can also be utilized for a variety of special and process applications.

Wall - Floor - Ceiling Mountings

Pre-heat and Re-heat Coils - 1.1 to 32.5 sq. ft. face.

Moderate tip speeds and outlet velocities

Optional Equipment

Mixing Box and Dampers • Face and By-pass Dampers • Throwaway, Cleanable or High Velocity Filters • Target, Grid or Pan Humidifiers.

Representatives in Principal Cities

Write for name of nearest representative and complete information on Air Conditioning Blower Units— Finned Coils — Evaporative Condensers — Cooling Towers — Sprayed Coil Dehumidifiers.

KENNARD CORPORATION • 1823 S. HANLEY ROAD ST. LOUIS 17, MO., U.S.A.

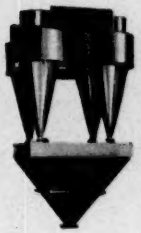
American Blower—a time-honored name in air handling

Venturafin Unit Heaters

Type TM Gyrol Fluid Drives

Utility Sets

Ventura Ventilating Fans



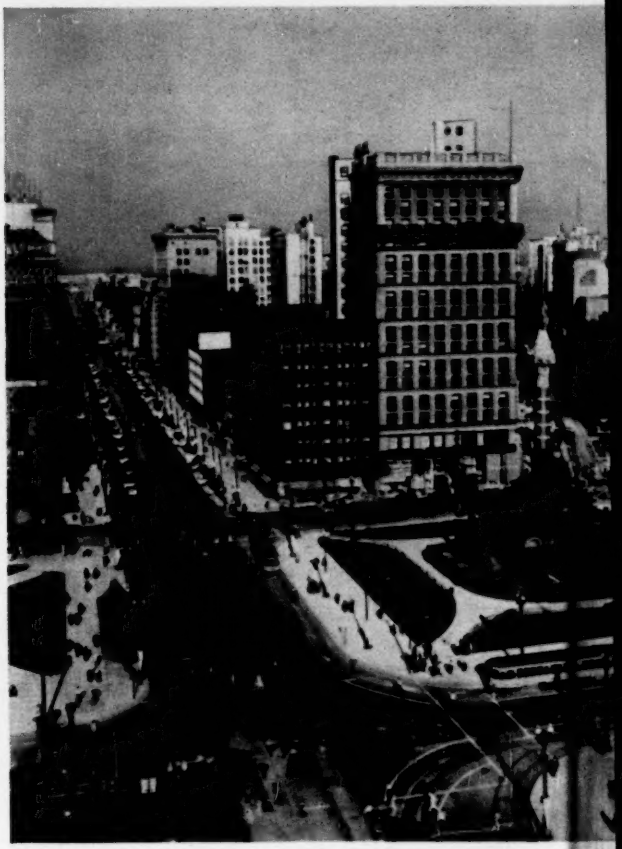
Dust Collectors

Mechanical Draft Fans

Industrial Fans

Heating and Cooling Coils

Air Conditioning Equipment

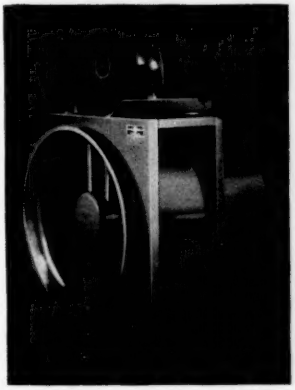


It pays to look before you buy. Air handling equipment differs widely in quality, design, quietness, operating costs and efficiency. Comparative tests by many buyers have thoroughly proved the superiority of American Blower Air Handling Equipment.

In Cleveland, as in other cities, American Blower Air Handling Products serve commerce, industry and public utilities. For air handling data in the Cleveland area, call American Blower—Main 6846. In other areas, consult your phone book.

Product of the month

American Blower Series 201 Axial Fans



They pay off in performance

American Blower vaneaxial fans are smooth in performance, built for endurance, and convenient to install. Guide vanes serve to transform waste energy into useful work and thereby make possible a substantial improvement in efficiency.

Tubeaxial fans have axial flow fan wheels and casing cylinders similar to the vaneaxial type but are furnished without directional guide vanes. The Series 201 tubeaxial fan is more than just a propeller fan in a cylinder. It is a rugged, smooth-operating, axial-type fan specially designed for moderate pressure duties.

Air is free. Why not let American Blower Fans help you use it profitably? For additional data, contact your nearest American Blower Branch Office.

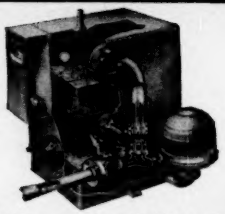
AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO

Division of American Radiator & Standard Sanitary Corporation

YOUR BEST BUY AMERICAN BLOWER AIR HANDLING EQUIPMENT

Serving home and industry

AMERICAN-STANDARD · AMERICAN BLOWER · CHURCH SEATS · DETROIT LUBRICATOR · KEWANEE BOILERS · ROSS HEATER · TONAWANDA IRON



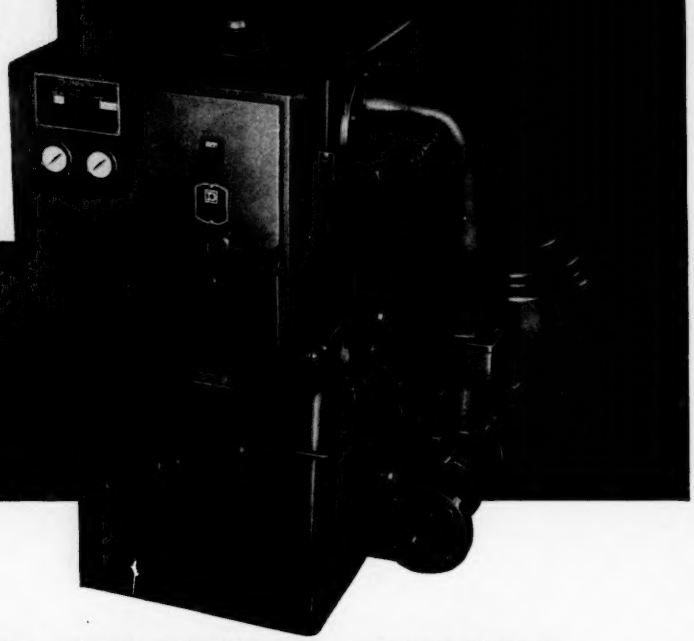
Design Features Worth Looking Into

Water Impeller is only principal moving part. No moving parts under vacuum. No close clearances.

Motors Mounted well above floor to protect against surface water; save floor space.

Easy to Install. 3 anchor bolts fasten pump to floor; no bars or bed plates needed.

steam circulation
UP
fuel costs . . .
DOWN



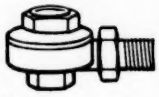
with

DUNHAM VACUUM PUMPS

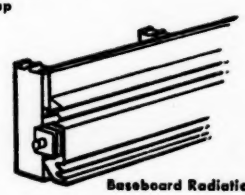
You get more value from fuel dollars with Dunham Vacuum Pumps. That's because these pumps easily produce *and maintain* the high vacuums—*up to 26 inches*—that assure rapid, efficient steam circulation . . . shorter "heating up" periods.

Easy to install and economical to maintain, Dunham Vacuum Pumps come in a full range of capacities—as single or duplex units—are ready for immediate operation as soon as piping and wiring connections have been made.

Check the *complete* Dunham line . . . whether you need a simple tight-seating, non-clogging radiator trap as shown at right . . . or enough baseboard radiation to comfortably heat any living area . . . you'll find the Dunham heating equipment line a good one to tie into. It's complete . . . it's fully dependable. For further information on Dunham Vacuum Pumps, write for Bulletin 1401-16. Similar literature available on other products.



Radiator Trap



Baseboard Radiation

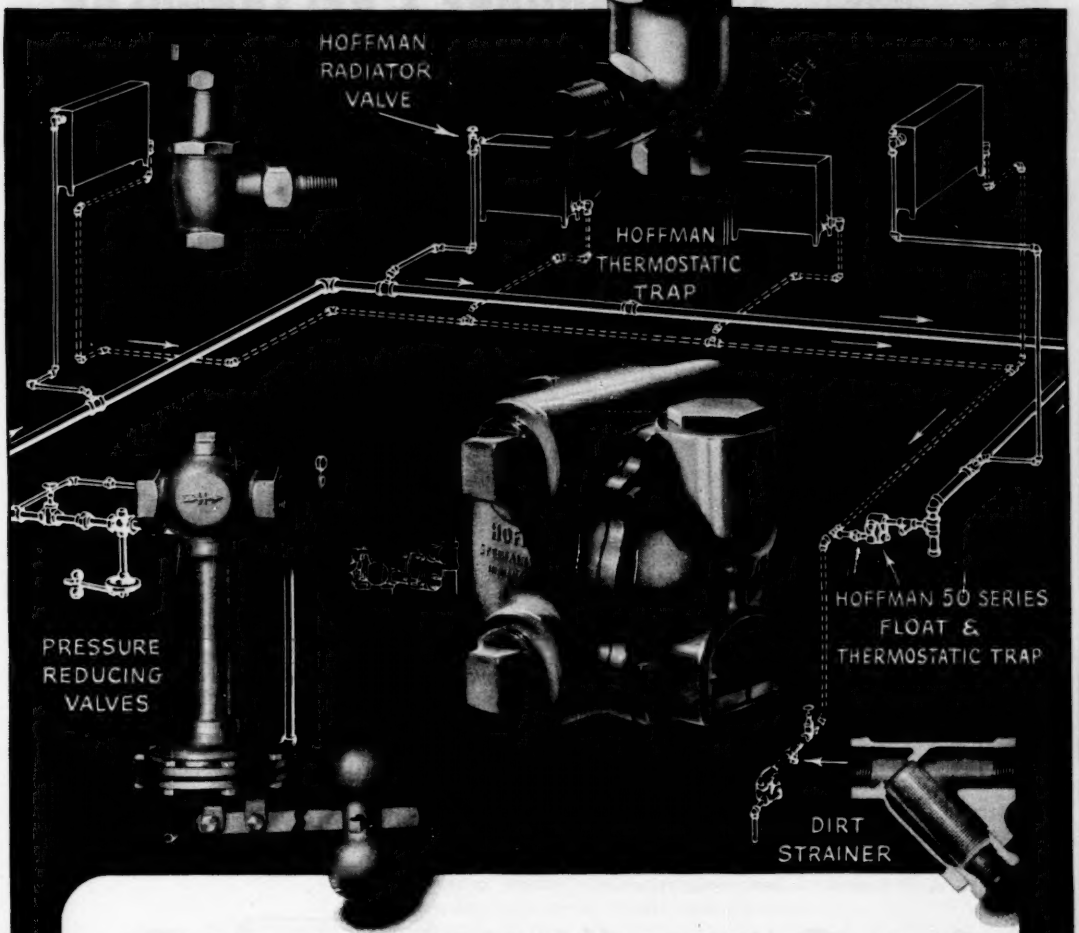
C. A. DUNHAM COMPANY
400 West Madison Street, Chicago 6, Illinois
In Canada: C. A. Dunham Co. Ltd., Toronto
In England: C. A. Dunham Co. Ltd., London

DUNHAM heating systems and equipment

Vari-Vac Differential Heating • Convector Radiation
Fin-Vector Radiation • Condensation Pumps • Horizontal and Vertical Discharge Heaters • Traps • Valves

HOFFMAN STEAM SPECIALTIES

FOR TWO PIPE GRAVITY STEAM HEATING SYSTEMS SUPPLIED WITH DISTRICT STEAM



From Hoffman's complete line of Valves, Traps and Steam Specialties you can specify the correct unit for every specific requirement. And, *each* Hoffman product is distinguished by exclusive features that assure customer satisfaction, long, care-free service. *It's the* COMPLETE, *tested, quality line* backed by a dependable, single source of supply and responsibility. *Yet Hoffman Products cost no more than the ordinary kind.* To avoid delays—order now from your wholesaler of heating and plumbing supplies. Ask for new Catalog No. 951, no obligation.

HOFFMAN STEAM SPECIALTIES

HOFFMAN SPECIALTY COMPANY, Dept. HV-12
VALVES, TRAPS, VACUUM AND COMPENSATION PUMPS, FORCED HOT WATER HEATING

1001 York St., Indianapolis 7, Ind.
SYSTEMS Sold by leading Wholesalers of Heating and Plumbing Equipment

Today... More Than Ever Before ONE DIFFUSER STANDS OUT!

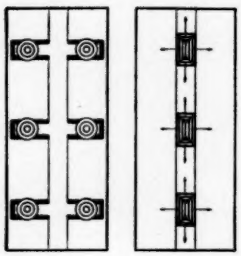
AGITAIR®

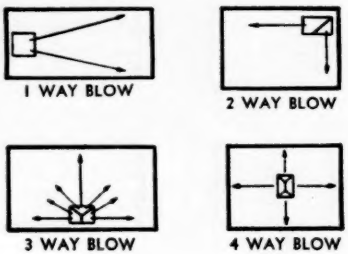
SQUARE & RECTANGULAR AIR DIFFUSERS

Save Metal... Cut Costs

SHORTER DUCT RUNS AND FEWER OUTLETS

Now you can conserve critical materials and cut costs without cutting efficiency. Check the diagram and note the shorter duct runs and fewer outlets when AGITAIR Type R diffusers are used.





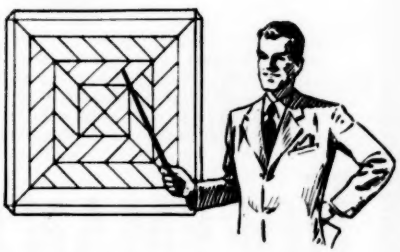
Tailor-Made TO YOUR SPECIFICATIONS

AGITAIR square and rectangular diffusers may be assembled in a variety of patterns to provide blows in one-two-three- and four directions with discharge orifices proportional to the area being served. Thus 100% air distribution is assured in any shape area, from any location without blank-off's or oversized outlets.

Greater Diffusing Ability

Patented built-in vanes deflect the air in numerous divergent streams resulting in turbulence at the point of contact with the aspirated air. Result: Rapid mixing, diffusion and temperature equalization.

Write For Complete Data



AIR DEVICES Inc. • **17 EAST 42nd ST.** • **NEW YORK 17, N. Y.**

AIR DIFFUSERS • AIR AND GREASE FILTERS • EXHAUSTERS

FOR PERFORMANCE YOU CAN **BANK** ON

Operating economy *is* an important factor in the selection of steam generating equipment; but equally important is dependability. These two basic considerations are such well-known attributes of Superior Steam Generators that Superior units are repeatedly specified for public utilities, hospitals, industrial plants, and similar critical installations.

Superior Steam Generators are built to develop their maximum rated capacities at thermal efficiencies guaranteed to exceed 80% . . . not for a day, or a month, but for years to come.

You can ***bank*** on their savings due to operating economy . . . but, more important, you can ***bank*** on the dependability of Superior Steam Generators for years of trouble-free service.

FOR COMPLETE DETAILS, WRITE TODAY FOR THE NEW FULLY ILLUSTRATED CATALOG 419 . . .

Fully automatic. Burns gas, or oil, or both.
18 sizes ranging from 20 up to 600 b.h.p.
for pressures to 250 p.s.i. or for hot water.

for performance you can **BANK** *on*

SUPERIOR COMBUSTION INDUSTRIES INC.
TIMES TOWER, TIMES SQUARE, NEW YORK 18, N.Y.

SUPERIOR STEAM GENERATORS

AND

New Airfoil Fan wheel with the side plate removed.

A CENTRIFUGAL FAN WITH AIRFOIL BLADING

Sturtevant Pioneers Again

Here's another major advance in fan design by Sturtevant —the new Airfoil Non-Overloading Centrifugal Fan.

In 1914, Sturtevant made high efficiency possible with the non-overloading centrifugal fan—the TURBOVANE®. Then, in 1930, low-cost Sturtevant VANE CONTROL® increased the efficiency of part-load operation. Now, in 1951, the new Sturtevant Airfoil blade achieves new heights in peak efficiency with "the wings of an airplane" housed in a centrifugal fan.

Higher Efficiency and Quieter Operation

Sturtevant's scientific application of Airfoil Blading produces a new high in efficiency and a new low in noise level:

Efficiency . . .	90% plus
Noise Level . .	65% less

Wherever operating cost means more than first cost—where evaluation and a reasonable price mean more than a low price—the Sturtevant Airfoil, Non-Overloading Fan is the answer.

Recent Purchasers

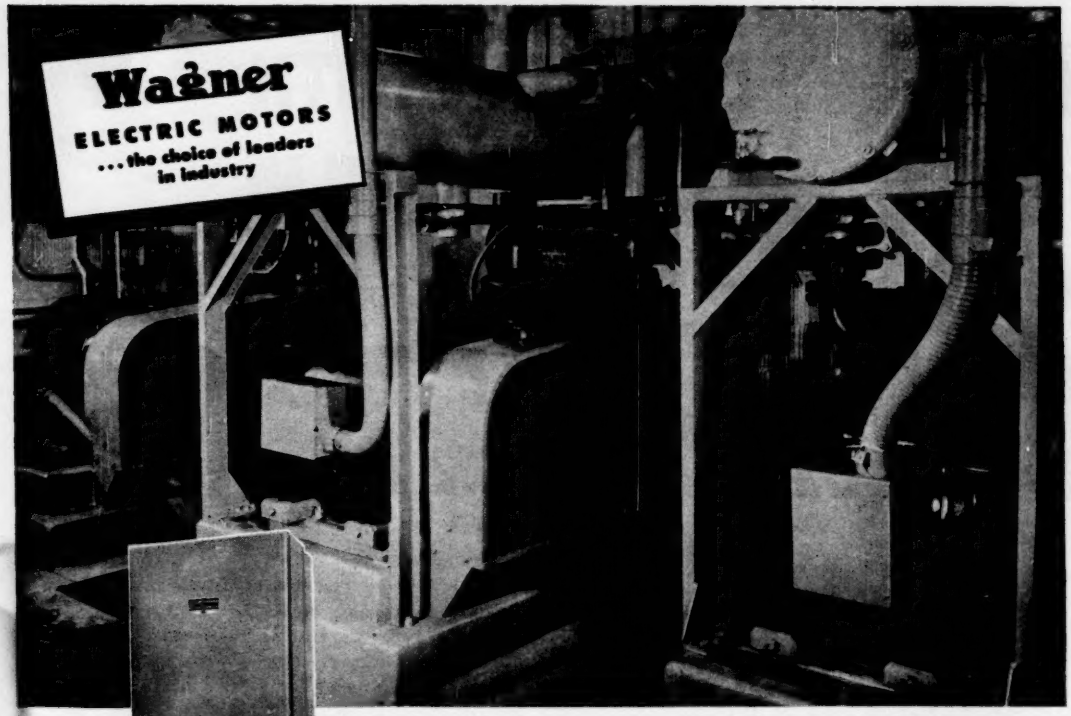
Airfoil Fans were selected by the Consolidated Edison Company of New York for their Astoria and East River Plants, and have been *successfully witness tested.* Other orders have been received from Duke Power Co., New York Gas & Electric Co., Pennsylvania Electric Co., Tennessee Valley Authority, and also for ventilation of the new Squirrel Hill Tunnel in Pittsburgh.

Where To Use

If low operating cost is of primary importance to you in your air handling applications, as it is in mechanical draft for utility and industrial power plants, in high-velocity air conditioning systems, and for vehicular tunnel ventilation, this new fan is available to you. For full information, contact your local Westinghouse-Sturtevant office, or write to Westinghouse Electric Corporation, Sturtevant Division, 168 Damon St., Hyde Park, Boston 36, Massachusetts.

YOU CAN BE SURE...IF IT'S Westinghouse

J-80244



Reduce starting current draw

the economical way with the Wagner Increment Motor and Starter Combination

On any application where reduced current draw at start is required because of locked current restrictions, you can limit the in-rush of motor current during the starting period with the low cost Wagner Increment Motor and Starter "Package."

A typical installation is shown in the photograph above, where three Wagner open-type general purpose motors rated 60, 100, and 125 hp are driving Worthington air conditioning units in a Minneapolis office building.

The Wagner Motor-Control Package is economical to install and permits the use of high grade magnetically operated control equipment at a low purchase price. For special requirements, the motor-control combination can be furnished with Wagner normal or high torque explosion-proof motors, splash-proof motors, or totally-enclosed fan-cooled motors as well as with the open type motor.

Why not investigate this Wagner combination today? Write for full information, or consult the nearest of Wagner's 31 branch offices, located in all principal cities.

Wagner Electric Corporation 1891 1951

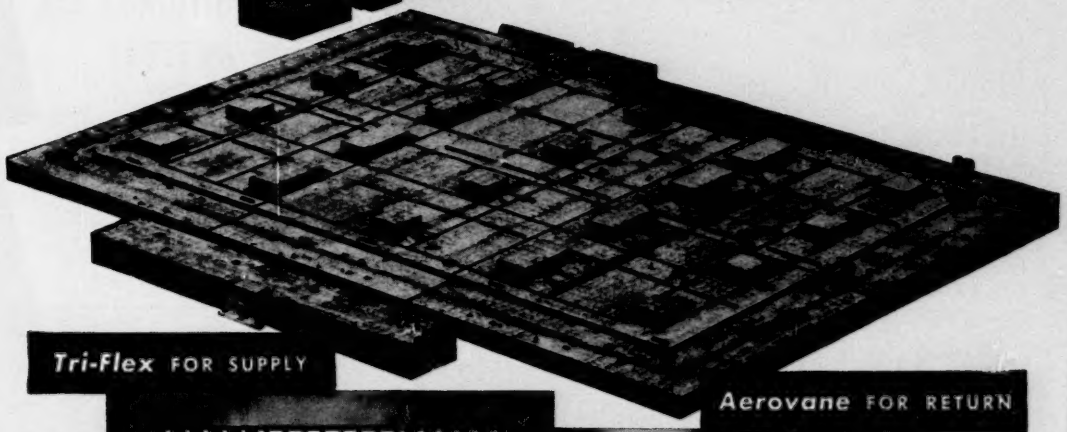
WAGNER ELECTRIC CORPORATION
6463 Plymouth Ave., St. Louis 14, Mo., U.S.A.

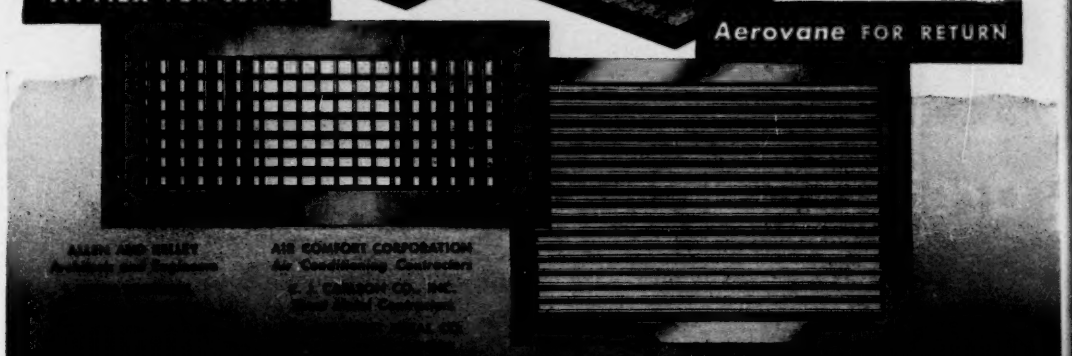
ELECTRIC MOTORS · TRANSFORMERS · INDUSTRIAL BRAKES
AUTOMOTIVE BRAKE SYSTEMS — AIR AND HYDRAULIC

BRANCHES IN 31 PRINCIPAL CITIES

M51-17

Tri-Flex . . . Aerovane . . in the Western Electric Company Indianapolis Plant





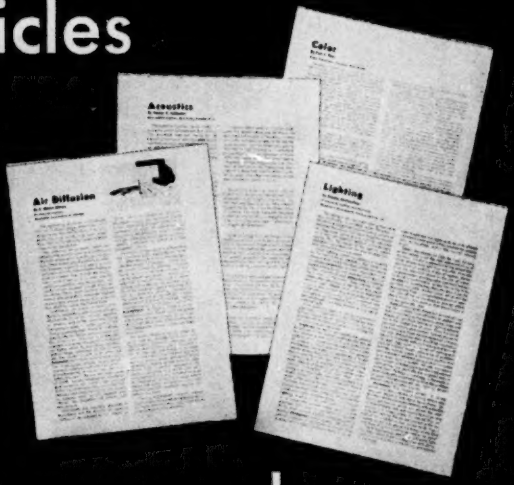
In outstanding buildings from coast to coast where air conditioning is important to improved working conditions or customer comfort . . . or essential to manufacturing processes, as it is in the new Indianapolis Plant of the Western Electric Company . . you'll find Tri-Flex and Aerovane Grilles and Registers installed at the all-important distribution end of the systems. The engineers, architects and contractors — the men responsible for the efficient performance of these jobs — know from experience they can depend on the Tri-Flex and Aerovane combination to insure the maximum, flexible control of air delivery necessary to meet the most exacting requirements.

Be wise, standardize . . . with T & B Standards.

TUTTLE & BAILEY inc

NEW BRITAIN, CONNECTICUT

four helpful articles



architectural designs

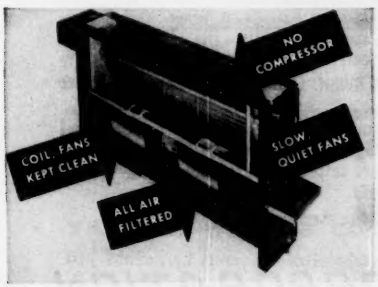
AIR CONDITIONING SYSTEMS *for* BUSINESS AND INDUSTRY

NEW DUN & BRADSTREET BUILDING in New York City has G-E Personal Weather Control Air Conditioning. Over 450 G-E room units circulate filtered, fresh air that is cool in summer, warm in winter. Architect: Reinhard, Hofmeister, & Walquist. Consulting engineer: Syska & Hennessy, Inc. General contractor: George A. Fuller Company. Air conditioning contractor: Kerby Saunders, Inc.

Cut first cost...and save in the long run, too, with

G-E PERSONAL WEATHER CONTROL

NO COMPRESSOR IN ROOM UNITS, just quiet, velvet-smooth fans and G-E motor. Room occupants can set temperature as they like without disturbing others. Units are supplied with attractive cabinets (above) or can be concealed in walls. Windows are never blocked.



ALL AIR FILTERED, protecting coils from dust which cuts performance drastically. Filters — inexpensive, changed in less than a minute—reduce room cleaning, avoid costly coil cleaning. Nine-inch deep unit takes little space, circulates air gently through large area.

HERE IS an air conditioning system that in most cases costs less to install...and goes on piling up savings for its owner through many years of operation.

It's General Electric Personal Weather Control, which heats in winter and cools in summer...utilizing individual G-E room air conditioners supplied with hot or chilled water through simple pipe runs from a central heating and refrigeration plant.

HOW YOU SAVE...Valuable space can be saved and alterations can be avoided by supplying ventilation through small-size ducts, the method used in the new Dun & Bradstreet Building (above) in New York City. Installation costs can be reduced even further by installing these systems with no ducts at all...using wall apertures for fresh air.

G-E Personal Weather Control often requires substantially less compressor capacity, saving both installed and operating cost. When rooms are unoccupied, units can be shut off. When there are few people in the building or the system is being started in the morning, units can be operated without the expense of running ventilation equipment.

MAKES YOUR BUILDING MORE PROFITABLE...Tenants enjoy living or working in buildings air conditioned by G-E Personal Weather Control. Each tenant can set the temperature of his room without disturbing others. And it's easier to rearrange office space, because G-E room units are flexible.

It's no wonder that G-E Personal Weather Control Air Conditioning is installed in Houston's Sterling Building ...12 Sheraton Hotels...the prominent new 575 Madison Avenue Building in New York City...and other leading buildings all over the United States.

GENERAL ELECTRIC

FREE DATA to architects, engineers, builders, contractors, and building owners.

General Electric Company, Air Conditioning Dept., Sec. HV-9, Bloomfield, N. J.

Please send me, without obligation, detailed information on G-E Personal Weather Control Air Conditioning.

NAME.....

COMPANY.....

ADDRESS.....

CITY.....ZONE.....STATE.....

Heating?

Cooling?

Air Conditioning?

Process?

Here's How to Get the RIGHT Answer to your HEAT-EXCHANGE PROBLEMS

The right ratio of surfaces – the right materials – the right velocities – the right proportion between coil area and depth . . . there are dozens of factors that affect the efficiency, maintenance and service life of heat-exchange coils.

For best performance in your own application, the practical approach is to take full advantage of the unequalled engineering, research and design skill – the unequalled manufacturing and testing facilities – which Aerofin offers you.

To get the *right* answer – ask the Aerofin man.

Aerofin is sold only by manufacturers of nationally advertised fan system apparatus. List on request.

AEROFIN CORPORATION

410 South Geddes St. SYRACUSE 1, N. Y.

these steam traps won't freeze up!

Freeze-ups of outdoor steam traps in winter weather often cause production delays. Don't take that chance . . . especially when it's so easy to install Yarways, the steam traps that *won't freeze up.*

They won't freeze because condensate does not accumulate. The only moving part—a little valve—is continually testing for condensate, discharging it as soon as it forms. There's never anything to freeze.

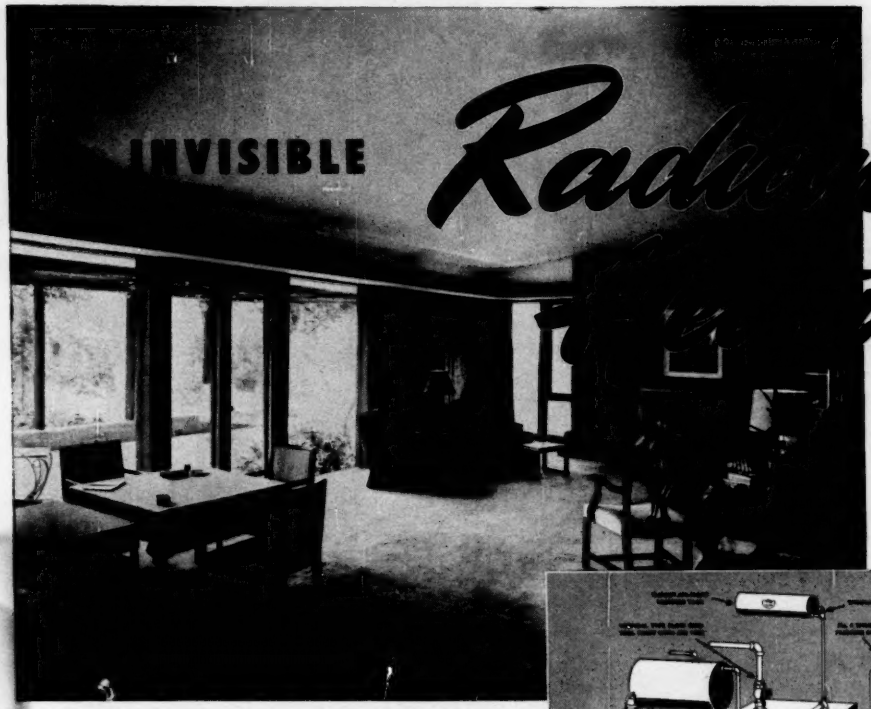
Other reasons why over 750,000 Yarway Impulse Steam Traps have been sold—they get equipment hotter, sooner; light weight; small size; easy to install and maintain; good for all pressures; made of stainless steel.

More than 200 industrial distributors sell Yarway Traps and Strainers. See your nearest one today. For name, and free 24-page Steam Trap Book, write . . .

YARNALL-WARING COMPANY
104 Mermaid Ave., Philadelphia 18, Pa.

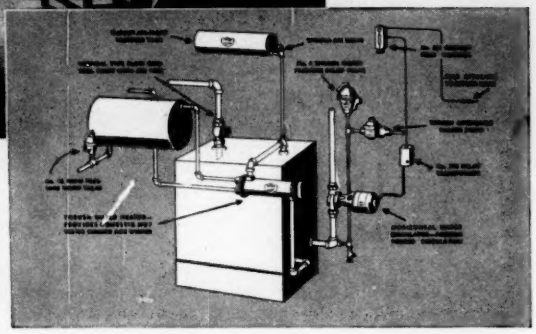
[redacted]

the steam trap designed with more production in mind



forced circulating

THRUSH FLOW CONTROL HOT WATER HEAT



THRUSH hot water heating system is flexible. With forced circulation and completely automatic control you can install any type of modern heating your customers desire and be sure of complete satisfaction. Heat from radiant coils hidden in ceiling or floor, radiant baseboards or convectors, with Thrush Flow Control System provide perfect comfort without overheating, automatically compensating for weather changes. Zoning is simple and inexpensive. Get all the facts on profitable Thrush equipment now. See your wholesaler today or write Dept. D-12

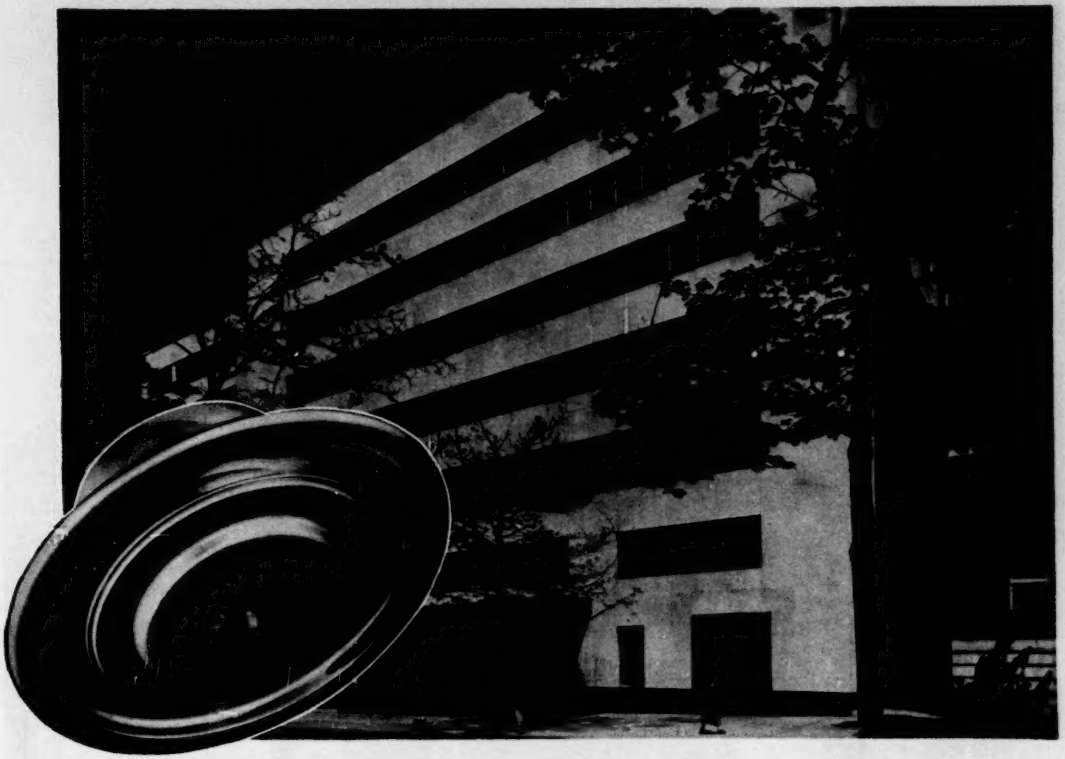
THRUSH HORIZONTAL WATER CIRCULATOR

THRUSH

H. A. THRUSH & COMPANY

PERU • INDIANA

Architects and Engineers: Albert Kahn Associated Architects and Engineers, Inc., Detroit, Michigan
Mechanical Contractor: Standard Engineering Co., Washington, D. C.



FOR APPEARANCE... FOR EFFICIENCY

kno·draft adjustable air diffusers

From first-floor pressroom to seventh-floor offices, The Washington Post's new building is completely air conditioned. Distribution is through Kno-Draft *Adjustable* Air Diffusers—smart in appearance, unobtrusive and, above all, *efficient.*

There are *no drafts* with Kno-Draft *Adjustable* Air Diffusers. Air distribution is gentle, maintaining an even temperature throughout the conditioned space. Air flow pattern and volume can be adjusted *after* installation—an important factor in operating efficiency and in reducing preliminary engineering.

Kno-Draft *Adjustable* Air Diffusers can be used in their natural spun aluminum finish, or painted to blend with ceilings. They are "at home" in either modern or traditional surroundings.

Let Connor Engineering Service work with you on your next air conditioning "specs." There are types and sizes of Kno-Draft *Adjustable* Air Diffusers for every requirement.

KNO-DRAFT DATA BOOK: Complete specifications, engineering and installation data on Kno-Draft *Adjustable* Air Diffusers. To get your copy, simply fill in and mail the coupon. No obligation, of course.

TRADE MARK "KNO-DRAFT" REG. U. S. PAT. OFF.

W. B. CONNOR ENGINEERING CORP.
Danbury, Connecticut
Air Diffusion • Air Purification • Air Recovery
In Canada: Douglas Engineering Co., Ltd.,
190 Murray Street, Montreal 3, P. Q.

W. B. CONNOR ENGINEERING CORP.
Dept. J-121, Danbury, Connecticut

Please send me, without obligation, my copy of the Kno-Draft Air Diffuser Data Book.

Name.....
Position.....
Company.....
Street.....
City.....**Zone**.....**State**.....

MULTI-VENT *Low Velocity Air Diffu*

T.M. Reg. U.S. Pat. Off. *CEILING PANELS*

in Fa

TEWAY CENTER BUILDINGS

Multi-Vent panels have been specified throughout for supplying both cooled and heated air in all the interior bays of the first three office buildings, now under construction.

Meyer, Strang &

Selected for . . .

TRULY DRAFTLESS, NOISELESS AIR CONDITIONED COMFORT . . .
for over 8000 office workers, summer and winter.

Plus these great advantages possible only with Multi-Vent...

COMPLETE FREEDOM IN LOCATING MOVABLE PARTITIONS
Partitions may even bisect a diffusing panel without disturbing in any way Multi-Vent's incomparable over-all uniformity of room air movement, temperature, and humidity.

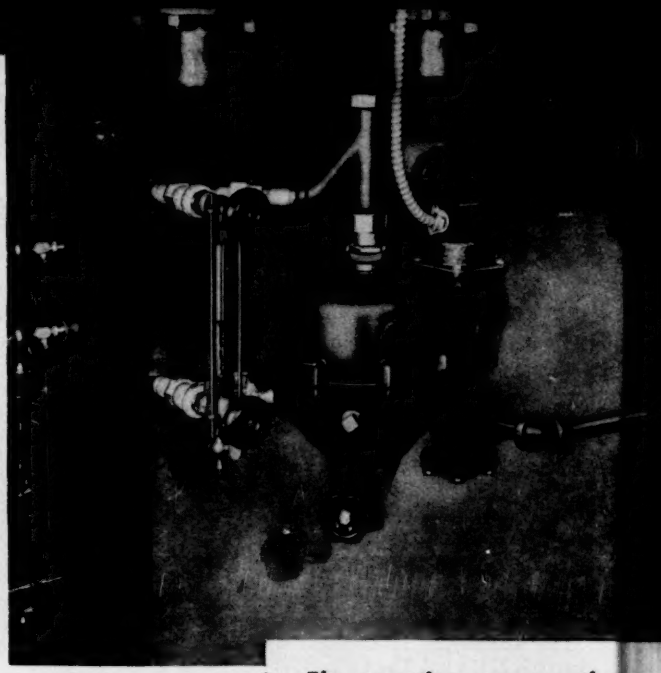
COMPLETE FREEDOM IN LOCATION OF LIGHTING FIXTURES . . .
for Multi-Vent panels are completely concealed in standard acoustical ceilings, and in no way interfere with interior design.

RADIANT PANEL HEATING AND COOLING EFFECT ADDS TO THE COMFORT FACTOR
The large areas of the ceiling which function as distribution plates for the Multi-Vent panels are heated or cooled to the temperature of the supply air.

See SWEET's Arch. & Eng. files or write for detailed literature.

MULTI-VENT DIVISION **THE PYLE-NATIONAL COMPANY**
1374 North Kostner Avenue Chicago 51, Illinois

THIS IS IT → → → →



Heating men keep wanting to know why we always recommend a combined water feeder and low water cut-off for all automatically fired boilers. Why, they ask, doesn't a simple low water cut-off fill the bill just as well?

The answer is that we wouldn't keep on making the best low water cut-off that money can buy if we didn't think it was a *good* idea; and, by the same token, we wouldn't keep on recommending a feeder-cut-off combination if we didn't think it was a *better* idea.

From any standpoint — safety or convenience — the combination is best because the two can accomplish more working together than either can alone. They compliment each other perfectly because the feeder gives *mechanical* protection and the cut-off gives *electrical* protection.

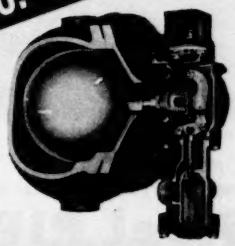
As brought out opposite and below, the feeder ordinarily functions as the first line of defense from low water — takes care of all normal operation of the boiler — and the low water cut-off stands by for the emergency as the last line of defense. Certainly the low water cut-off would be the final defense, if prolonged and extreme priming or foaming occurred or if the water supply failed. But just the same there are times when the feeder may save a boiler that the low water cut-off could not save . . . on a stoker fired boiler, for instance, where interrupting the current merely stops the blower, but permits some firing to continue; or on a gas-fired boiler if the electric valve failed to operate.

Yes, your first recommendation for every automatically fired boiler should be a feeder-cut-off combination; not because it is more profitable for you, but because it is best for your customer. If the boiler owner refuses to pay for the combination, next best choice of course is a McDonnell Low Water Fuel Cut-off.

McDONNELL & MILLER, INC.
3500 N. Spaulding Ave., Chicago 18, Ill.

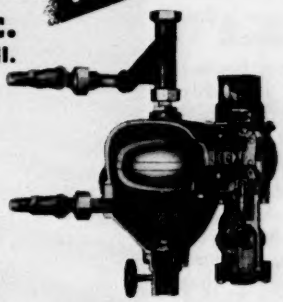
Doing One Thing Well

No. 51-2



This feeder-cut-off combination operates exactly the same as the No. 47-2, but has the greater capacity required by boilers above 5000 sq. ft.; maximum steam pressure, 35 lbs.

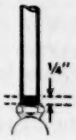
No. 47-2



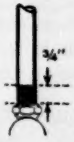
The feeder-cut-off combination at its best, McDonnell No. 47-2 for automatically fired boilers up to 5000 sq. ft.; maximum steam pressure, 25 lbs.

The operating sequence that makes the boiler water level as automatic as the firing . . .

1 The feeder (mechanical control) takes care of all normal operation — feeds make-up water only when needed and as much as needed.



2 But if an emergency occurs, such as extreme priming and foaming, or any other condition arises so that the feeder can not keep up with feeding requirements, the switch (electrical control) interrupts the current to the burner.

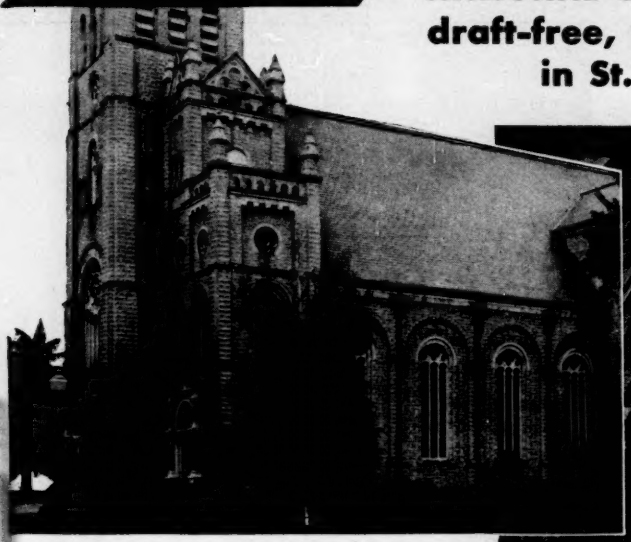


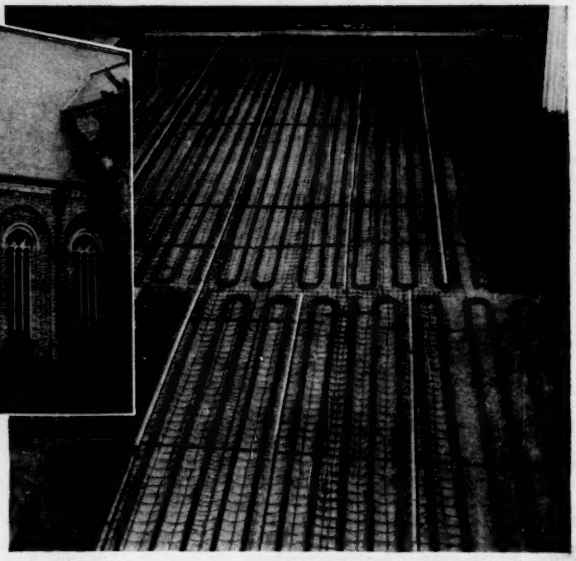
3 As soon as the emergency has passed the control is returned to the feeder. This is the fully automatic sequence of operation that is possible only with a feeder-cut-off combination.

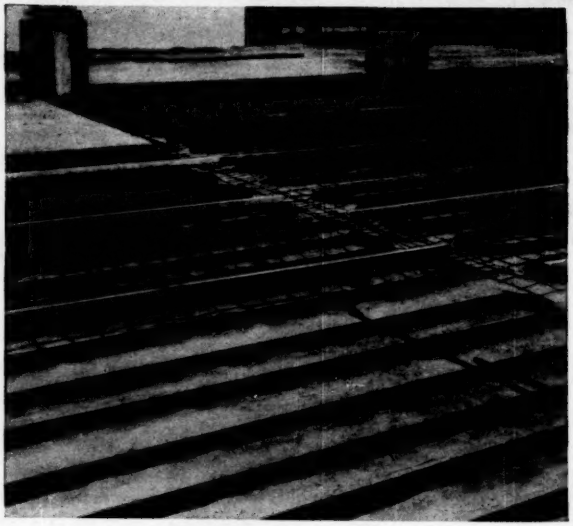
Your Jobber Name Here

McDONNELL

NOW . . . modern radiant heating with NATIONAL STEEL PIPE assures draft-free, year-round comfort in St. John's Church







ST. JOHN'S CHURCH in Delphos, Ohio, is a good example of a hard-to-heat building made comfortable with radiant heating.

The auditorium in this beautiful old stone church is 135′ x 65′. The vaulted ceiling is over 65′ high. Here was a natural for radiant heating.

To keep installation costs down, the insulating paper was laid right over the old wood floor. Then came ¾″ steel bars. Finally, 10,110 feet of 1¼″ National Steel Pipe was tied to the bars and over this a 2″ layer of concrete was poured.

Now, at last, the floors are warm. The entire auditorium is comfortable. And the room is free from obstructions, hot spots and cold spots.

Why did they use National *Steel* Pipe? For one thing, it's economical in cost . . . it is readily welded, it is strong, yet sufficiently ductile to permit easy bending. But best of all is its record for long life and trouble-free service. It has been standard for conventional hot water heating for over 60 years.

If you are planning a future radiant heating installation for a church, garage, store, terminal, factory, warehouse or plant, remember that National—the world's largest selling pipe—has all the qualities that make for a successful application.

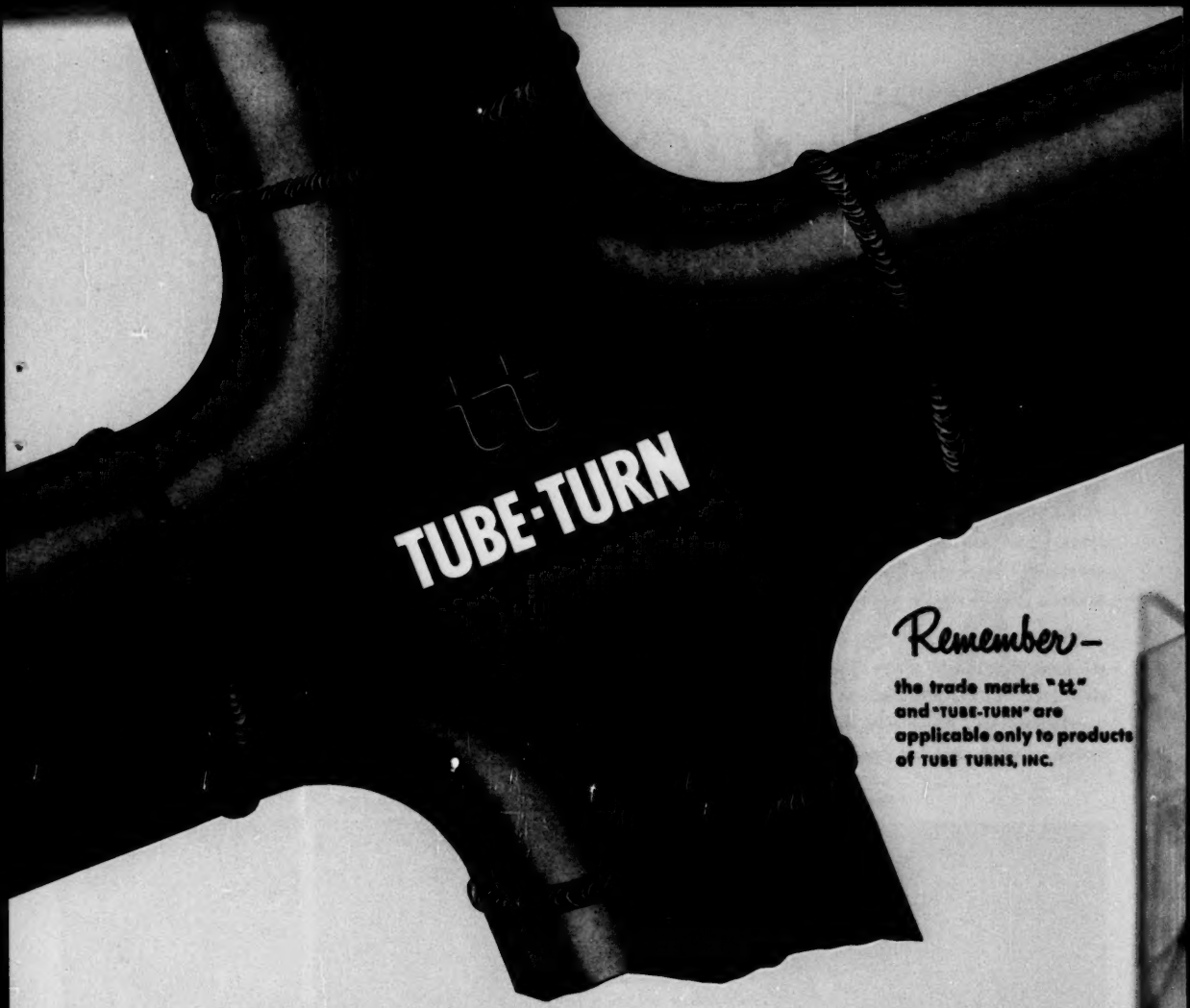
USS

NATIONAL TUBE COMPANY, PITTSBURGH, PA.

COLUMBIA STEEL COMPANY, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS · UNITED STATES STEEL EXPORT COMPANY, NEW YORK

NATIONAL Steel PIPE

UNITED STATES STEEL



Remember—

the trade marks "tt" and "TUBE-TURN" are applicable only to products of TUBE TURNS, INC.

It's a neat job...and it's stronger

● Welded piping systems are streamlined. They save space, are easier to insulate and are permanently leakproof.

For a complicated connection like this, use of the TUBE-TURN Welding Cross also means extra strength. This welding cross is made from the same seamless tubing and by the same process as TUBE-TURN Welding Tees. Bursting pressures obtained in tests of representative tees and crosses have averaged more than 25% higher than required by standard codes. This gives you extra quality at no extra cost.

Welding your piping with TUBE-TURN Welding Fittings means a neater design and stronger construction. Get in touch with your nearby TUBE TURNS' Distributor. There's one in every principal city.

Write Dept. B-12 for free booklet, "Allowable Working Pressures".

Be sure you see the double "tt"

TUBE TURNS, INC. LOUISVILLE 1, KENTUCKY

DISTRICT OFFICES: New York • Philadelphia • Pittsburgh • Chicago • Houston • Tulsa • San Francisco • Los Angeles

TUBE TURNS OF CANADA LIMITED, CHATHAM, ONTARIO... A wholly owned subsidiary of TUBE TURNS, INC.

50 miles of *permanent piping* in world's tallest building

● In construction of the Empire State Building, designers wanted to eliminate piping maintenance.

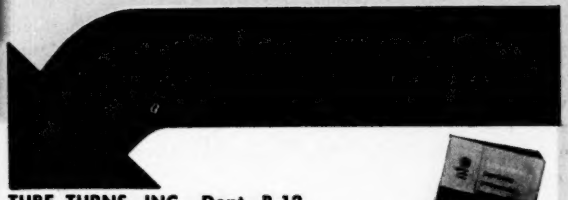
That's why a welded piping system, using TUBE-TURN Welding Fittings, was specified for all critical lines, employed for heating, refrigeration and other services. The original, and additional piping since added, continues to give leakproof permanence.

That's mighty important when you consider that the structure has 50 miles of piping, which last year delivered 72,000,000 pounds of steam, in addition to other services. Moreover, the system has conserved space, and provided optimum flow conditions.

Workman applies finishing touches to insulation on new 12" chill water lines. Note ease of applying insulation on TUBE-TURN Welding Elbows. With no flanges to work around, piping can be much more compact.

Steam header fabricated with TUBE-TURN Welding Fittings feeds 8", 10", and 14" lines with steam at 150 psi. From central heating plant, steam flows to steam stations for distribution to different areas.

New water cooling plant will supply tenants with modern air conditioning facilities. Here, use of TUBE-TURN Welding Elbows and Welding Reducers simplifies piping to refrigeration machinery, and assures a leakproof system. Plant will eventually develop 3500 tons of refrigeration.



TUBE TURNS, INC., Dept. B-12
224 East Broadway, Louisville 1, Kentucky

Your Name .....
Position .....
Company .....
Nature of Business .....
Address .....
City ..... *State* .....

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Philadelphia	Tulsa
Pittsburgh	San Francisco
Chicago	Los Angeles

Be sure you see the double "tt"

TUBE TURNS, INC.

LOUISVILLE 1, KENTUCKY

FRESH AIR "MADE TO ORDER"

Saves money!

Saves critical materials!

Make DOREX AIR RECOVERY part of your air conditioning or heating installation

Here's what we mean by "made-to-order" fresh air:

To maintain air quality, your ventilation system must continually bring in air from the outside. You have to heat or cool this air—which costs money. But when Dorex Air Recovery is part of the system, only about one-third as much outside air need be taken in. Dorex supplies the rest by making fresh air "to order" from the used air that has already been conditioned.

This is done simply by passing the used air through Dorex C Cells—containers of activated carbon that extract all odorous and gaseous impurities. The air you have already paid good money to heat or cool comes out just as fresh and usable as air from the outside.

Now, let's look closer at savings. You save critical materials because substantially less heating and cooling equipment is required. You save money because you have far less air to condition. On the basis of 20 years' experience and over 7,000 Dorex installations, you can safely figure a $400 saving on original equipment for every $100 invested in Dorex Air Recovery . . . and a $4 saving in operating costs for every $1 spent for Dorex maintenance.

Get the full story of Dorex Air Recovery. Mail the coupon today.

DOREX

Air Recovery

W. B. CONNOR ENGINEERING CORP.

Danbury, Connecticut

Air Diffusion • Air Purification • Air Recovery

In Canada: Douglas Engineering Co., Ltd., 190 Murray Street, Montreal 3, P. Q.

TRADE MARK "DOREX" REG. U. S. PAT. OFF

W. B. CONNOR ENGINEERING CORP.
Dept. B-121, Danbury, Connecticut

Please send me, without obligation, full information on Dorex Air Recovery

Name .....

Position .....

Company .....

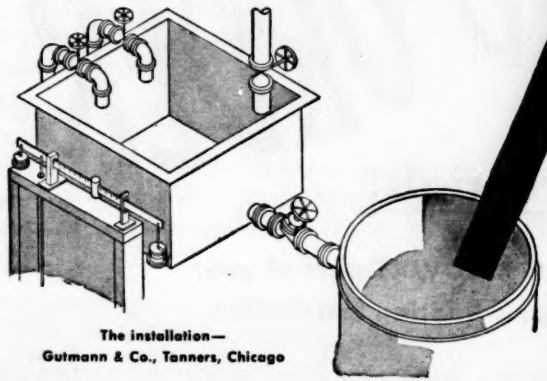
Street .....

City ..... Zone ..... State .....

for outstanding service

on Chrome Tanning Liquor

. . . for example



The installation—
Gutmann & Co., Tanners, Chicago

PROBLEM: To find a better replacement for valves and cocks used on outlet of open scale tank. Constant trouble with seat leakage, corrosive wear, seizing, and stuffing box maintenance.

WORKING CONDITIONS: Solution handled—highly corrosive basic sulphate of chrome used in tannage of Chrome upper leather. Several batches mixed daily. Gravity flow from scale tank.

SOLUTION TO PROBLEM: Crane No. 1615 Iron Body, packless Diaphragm Valve, Neoprene lined, featuring separate disc and diaphragm design.

RESULT: After more than 2½ years of steady, leak-free service, Crane Diaphragm Valve shows no sign of corrosive or erosive effects . . . no undue mechanical wear . . . operates as smoothly as new. Maintenance cost to date—zero.

Another typical case history demonstrating how Crane Quality Valves assure low ultimate cost. And why . . . More CRANE VALVES are used than any other make!

. . . Switch to Performance-Proved CRANE VALVES

No. 1615 Crane Iron Body Diaphragm Valve. Get literature on this full line of multi-purpose valves from your Crane Branch or Crane Wholesaler.

CRANE CO.

General Offices:
836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING

BRUNNER SINCE 1906

REFRIGERATION helps you serve better

There are just two steps to closing more business

THE FIRST STEP IS—*use this coupon*

Just fill it in and mail it

We will know this is your request for a Brunner factory representative to stop in and go over the reasons why Brunner dealers find it easier to close business.

Name

Company

Address

City and State

With all the facts fresh in mind you will recognize the second step—recommend and install Brunner's from now on. With 69 models comprising a complete range of commercial capacities and types, a dependable source of supply and a known product with ready acceptance by your customers, selling obstacles are removed and you are on the way to bigger business. We will be looking for the coupon.

BRUNNER MANUFACTURING COMPANY
Utica 1, New York, U. S. A.

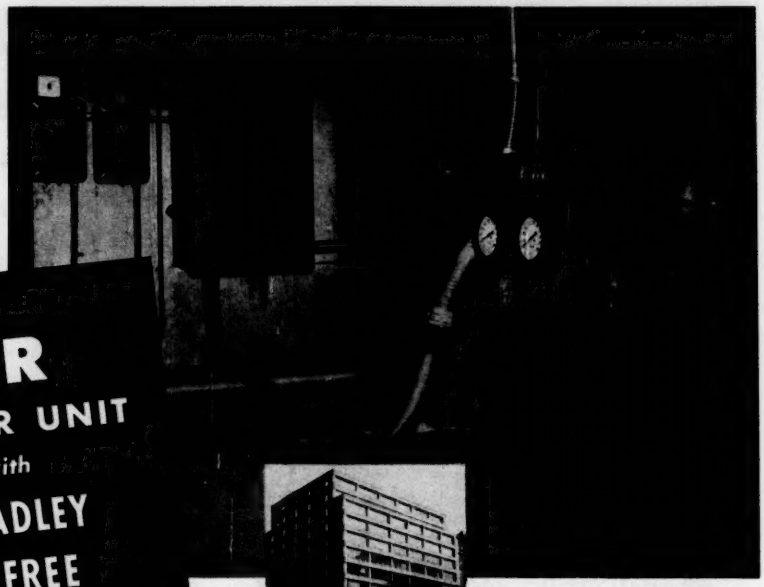
REFRIGERATION CONDENSING UNITS
...a size and type for every purpose

BRUNNER SINCE 1906

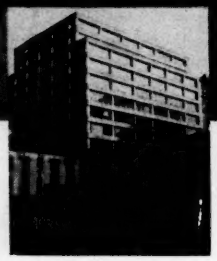
AIR AND WATER COOLED MODELS
¼ HP. to 75 HP.

BRUNNER SINCE 1906

AIR CONDITIONING
Self Contained Units in 4 sizes: 3-5-7½ and 10 HP.
Remote Installation Types from 3 to 75 HP.



BAKER
COMPRESSOR UNIT
equipped with
ALLEN-BRADLEY TROUBLE FREE MOTOR CONTROLS



Kass Realty Company Building in Washington, D. C., is completely air conditioned, using Baker compressors equipped with reliable Allen-Bradley Bulletin 709 Automatic Starters.

A-B Quality

Why are Allen-Bradley automatic starters so popular for refrigeration and air-conditioning service? . . . Because they are trouble free. Only ONE moving part. No pivots, pins, or bearings to corrode or stick . . . no jumpers to break. You install them . . . and forget them!

No contact maintenance . . . Allen-Bradley cadmium silver alloy contacts never need cleaning, filing, or dressing.

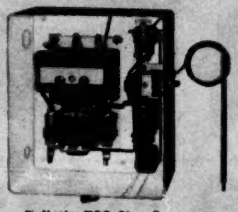
Dependable overload relays . . . Allen-Bradley thermal relays are accurate and always dependable . . . even after long service.

The Allen-Bradley trademark stands for millions of trouble free operations.

Allen-Bradley Co.
1330 S. Second St., Milwaukee 4, Wis.

ALLEN-BRADLEY SPECIAL REFRIGERATION CONTROL UNITS

Allen-Bradley offers a wide line of air-conditioning and refrigeration controls — pressure and temperature controls, manual and automatic starters, and special refrigeration control units. The two units at the right show Allen-Bradley special refrigeration control units consisting of solenoid starter, high pressure cutout, thermostat, and manual starting switch. You can install A-B controls and forget them.



Bulletin 709 Size 2 Starter Unit

Bulletin 709 Size 1 Starter Unit

ALLEN-BRADLEY SOLENOID MOTOR CONTROLS

JENKINS PRACTICAL PIPING LAYOUTS 57

How to plan
CONNECTIONS FOR COMMONLY USED TYPES OF METERS

In practically all industries meters are used to compute, accurately and automatically, the amount of flow. Fluids measured may be liquid, gas, or vapor (water, oil, gasoline, fuel gas, steam). Diagrams show the basic piping hookups for some of the more commonly used meters.

Orifice Type — generally used to indicate, totalize, and record moderate quantities of liquids, gases, or vapors.

Venturi Type — also indicates, totalizes and records. It is frequently used on condenser water supply units in power stations, water pumping stations, and sewage plants.

Area Flow Type — or Rotameter is for indicating, principally, in lines carrying fluids in moderate quantities.

Displacement Meter — usually totalizes only; this is the type used to measure water supply from city mains to buildings.

Valve recommendations include bronze, for ordinary service, and stainless steel where corrosive liquids are handled. Jenkins Fig. 106-A Bronze Globe is especially suited for shut-off service as recommended in these hookups. Jenkins All-Iron Valves are also available where desired.

Consultation with meter manufacturers is recommended to determine the type best suited for your particular service.

A CHOICE OF OVER 500 VALVES

To save time, to simplify planning, to get all the advantages of Jenkins specialized valve engineering, select all the valves you need from the Jenkins Catalog. It's your best assurance of *lowest cost in the long run*. Jenkins Bros., 100 Park Ave., New York 17; Jenkins Bros., Ltd., Montreal.

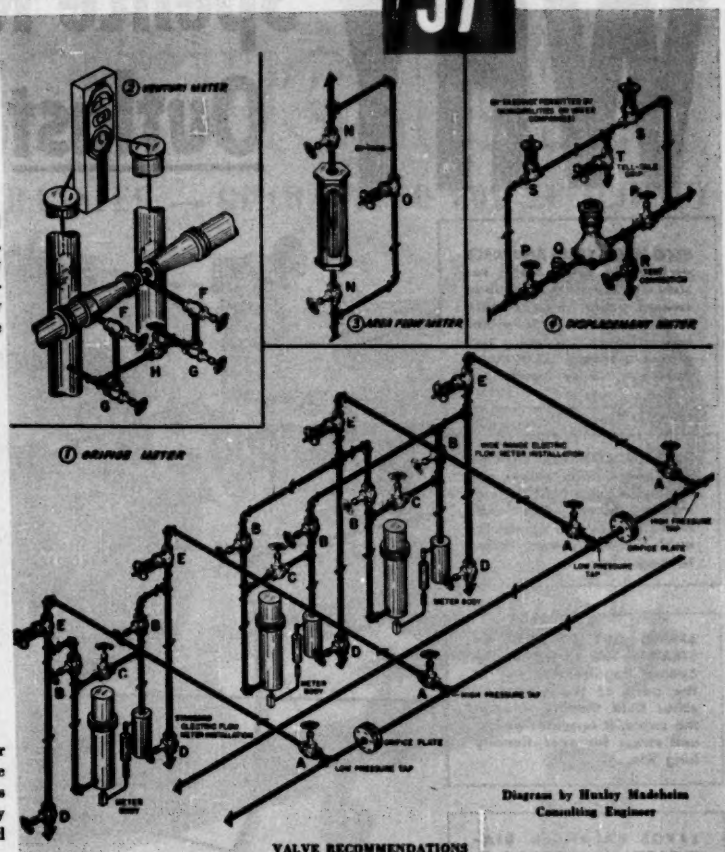


Diagram by Huxley Madeheim
Consulting Engineer

VALVE RECOMMENDATIONS
For details of valves to suit varying conditions see Jenkins Catalog.

	JENKINS VALVES					
	Code	Quan.	Bronze	Stainless		Service
ORIFICE METER	A	4	106-A	1308	Globe	Orifice Tap Shutoff
	B	6	106-A	1308	Globe	Meter Body Shutoff
	C	3	741-G	1308	Globe	Equalizing Line
	D	4	106-A	1308	Globe	Drain & Blow Down
	E	4	47-U	1302	Gate	Main Shutoff or Meter
VENTURI METER	F	2	108-A	1310	Angle	Piezometer Tap Shutoff
	G	2	108-A	1310	Angle	Tap Shutoff to Water Cock
	H	1	741-G	1308	Globe	Equalizer
AREA FLOW METER	N	2	106-A	1308	Globe	Meter Shutoff
	O	1	47-U	1302	Gate	By-Pass
DISPLACEMENT METER	P	2	47-U	1302	Gate	Meter Shutoff
	Q	1	92	1328	Check	Anti Back Flow
	R	1	106-A	1308	Globe	Test Connection
	S	2	47-U	1302	Gate	By-Pass
	T	1	47-U	1302	Gate	Tell Tale Drip

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JENKINS
LOOK FOR THE DIAMOND MARK
VALVES
SINCE 1864
TRADE JENKINS MARK
Jenkins Bros

COMPLETE DESCRIPTION AND ENLARGED DIAGRAM OF THIS LAYOUT FREE ON REQUEST. Includes additional detailed information. Simply ask for Piping Layout No. 57.

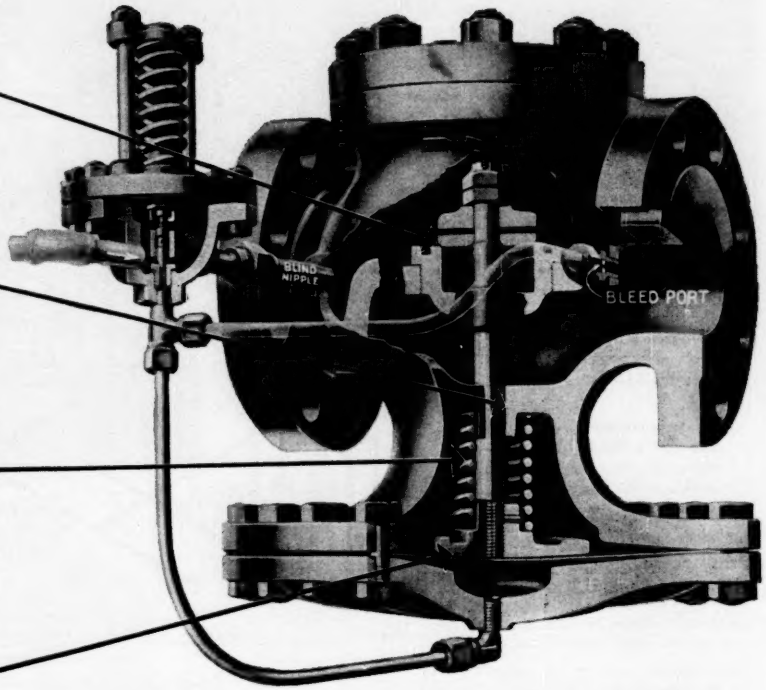
WHY Spence Regulators Outlast The Field

SECO METAL SEATS AND DISCS — Durable SECO Metal resists wiredrawing. More than twenty years of experience in thousands of installations has failed to produce a single case where SECO Metal has been cut by steam.

PACKLESS CONSTRUCTION — All Spence main valves and most pilots are built without stuffing boxes. This minimizes friction . . . eliminates much time-consuming maintenance.

SPRING OUT OF PATH OF STEAM — The spring in the Spence Regulator is out of the path of the steam or other fluid flowing through the valve. It operates at low unit stress for exceptionally long life.

LARGE BALANCED DIAPHRAGM—Spence metal diaphragms, under usual conditions, never require replacement. Spence Regulators have few moving parts and those few are ruggedly constructed and seldom require attention.



Spence Type EQ back pressure regulator-operation of main valve is controlled by a sensitive pilot to regulate the initial pressure. Same pilot is used with all sizes of main valves.

The features shown above explain why you profit on every important count with Spence Pressure and Temperature Regulators.

Learn more about these and many other advantages of Spence Regulators by sending for Bulletin 350.

DURABILITY — Spence Regulators perform dependably year after year.

ACCURACY — You can be sure of accurate control for the life of the regulator.

MAINTENANCE — You don't need expensive repairs or special maintenance. That means less down-time, less time and money wasted on replacement of parts.

BB-110

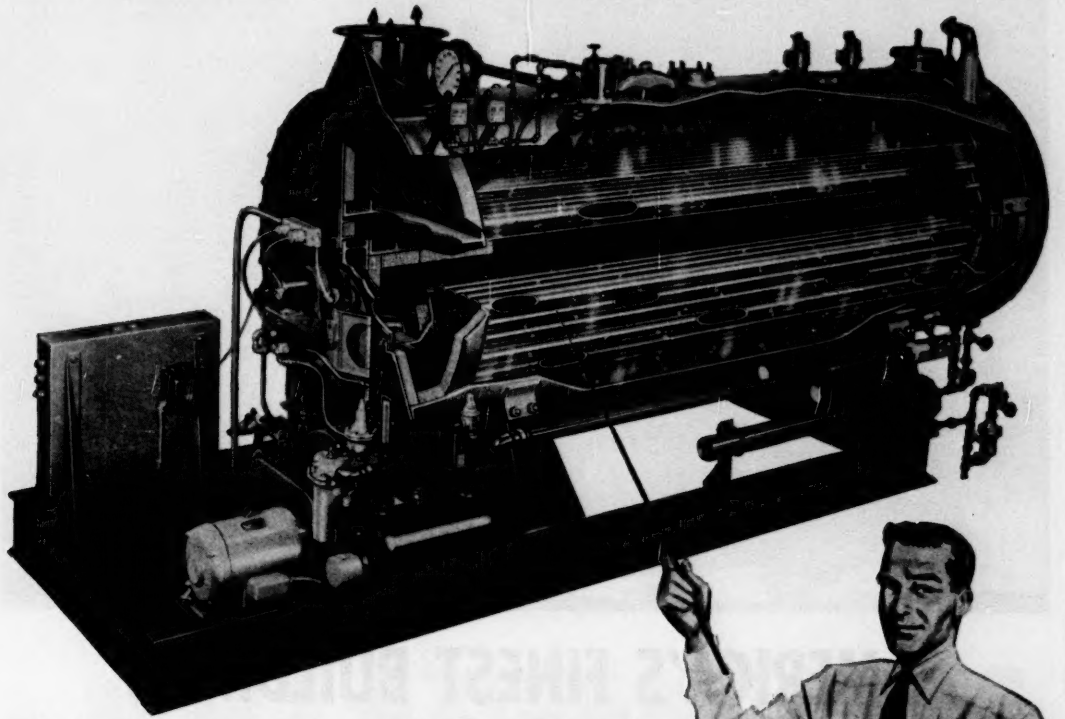
SPENCE ENGINEERING COMPANY, INC.
WALDEN, NEW YORK

Spence

CLEAVER-BROOKS STEAM BOILER

Four-Pass Construction

MEANS HIGH HEAT TRANSFER — GUARANTEED 80% EFFICIENCY



The basic reason for the high thermal efficiency and low fuel costs of Cleaver-Brooks Steam Boilers is graphically shown above.

Note the original and exclusive Cleaver-Brooks four pass construction of the boiler. The four complete passes of combustion gases traveling through the entire tube length of the boiler proper enables the boiler to absorb the greatest practicable amount of heat from the fuel burned.

All Cleaver-Brooks boilers are of the four pass design and the maximum useable heat is absorbed in these four passes before the combustion gases leave the boiler.

Cleaver-Brooks steam boilers offer many advantages . . . quick, effortless response to fluctuating steam demands — minimum manpower needed for operation and maintenance — clean — space saving — low cost installation — dependable performance — burns the fuel most available and most economical in your area — oil or gas.

Remember the name Cleaver-Brooks, it stands for the first and finest in steam boilers. Standard models available in sizes from 15 to 500 HP, 15 to 250 psi, oil, gas, combination oil and gas firing.

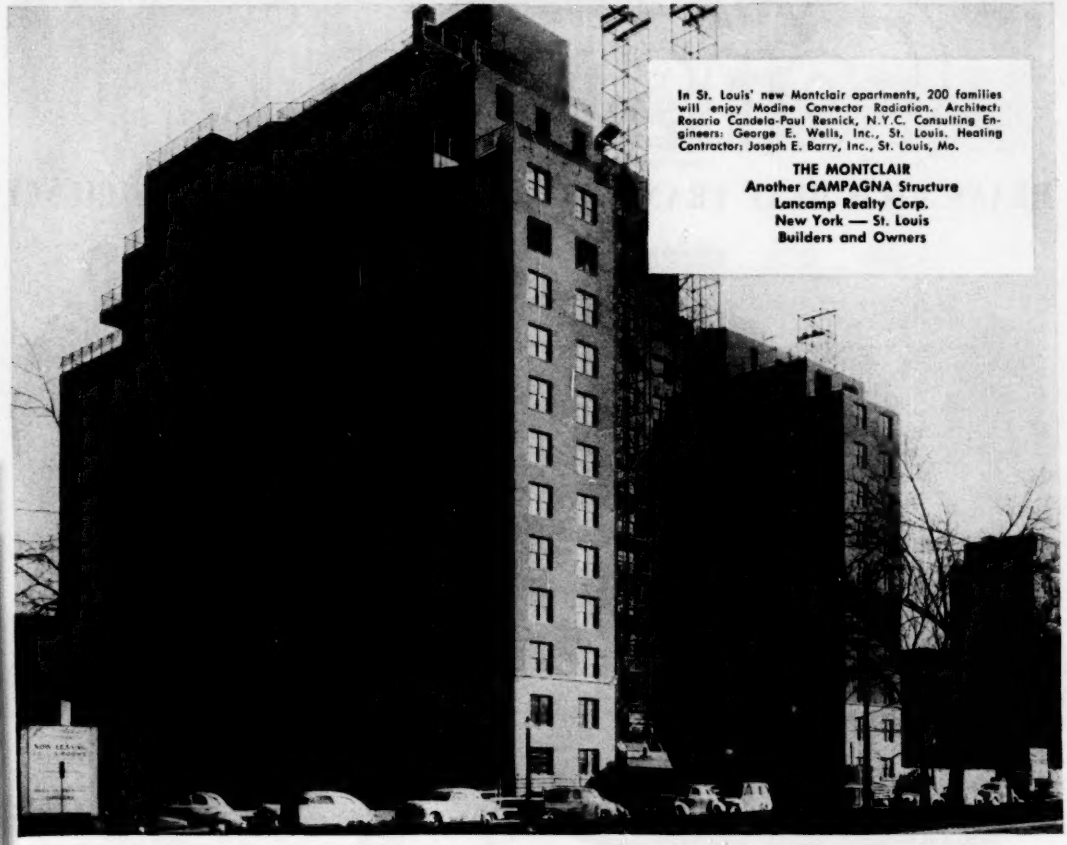
CLEAVER-BROOKS COMPANY
315-M E. Keefe Ave., Milwaukee 12, Wis.

Builders of Equipment for the Generation and Utilization of Heat • Steam Boilers • Oil and Bitumen Tank-Car Heaters • Distillation Equipment • Oil and Gas-Fired Conversion Burners

Write for your copy of the latest illustrated Cleaver-Brooks Boiler Catalog. It tells and shows why Cleaver-Brooks Boilers will save you money.

Cleaver-Brooks
STEAM BOILERS
the first and finest of their class

THE MONTCLAIR IN ST. LOUIS CHOOSES MODINE



In St. Louis' new Montclair apartments, 200 families will enjoy Modine Convector Radiation. Architect: Rosario Candela-Paul Resnick, N.Y.C. Consulting Engineers: George E. Wells, Inc., St. Louis. Heating Contractor: Joseph E. Barry, Inc., St. Louis, Mo.

THE MONTCLAIR
Another CAMPAGNA Structure
Lancamp Realty Corp.
New York — St. Louis
Builders and Owners

AMERICA'S FINEST BUILDINGS USE AMERICA'S FINEST CONVECTORS

Modine Convectors come in three distinctive enclosures — Type F (shown) for free-standing or recessed installation, Types W and S for wall-hanging.

More and more Modine Convectors are being specified to meet the high standards of excellence demanded of modern heating equipment.

There are sound reasons for this popularity. Foremost is *quality* . . . proved by the universal acceptance which Modine Convectors have enjoyed among architects and engineers for more than twenty years.

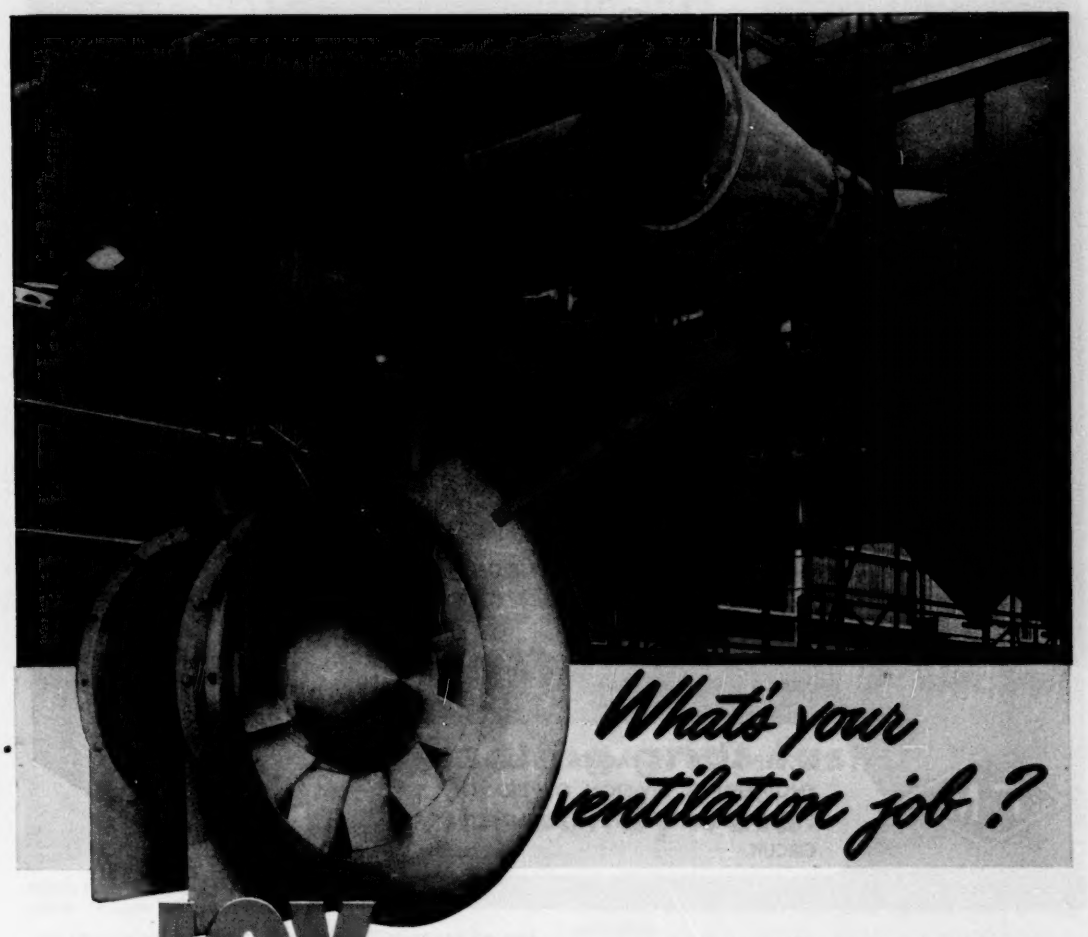
With Modine, quality is no idle catchword. It's *real* . . . a result of sound engineering — highest grade materials — advanced manufacturing techniques — skilled craftsmanship — and a rigid quality-control program.

To measure this quality, personally inspect a Modine Convector on the job or in your office. Talk with owners. You'll find unmatched styling — superior enclosure and heating unit construction — longer life — and better heating performance.

Call your Modine representative listed in your classified phone book, or write Modine Mfg. Co., 1511 DeKoven Ave., Racine, Wis.

R-1114

Modine CONVECTORS



What's your ventilation job?

JOY AXIVANE* FANS

WILL DO IT MORE EFFICIENTLY AND MORE ECONOMICALLY!

Write for Bulletin, or *Consult a Joy Engineer*

From every possible angle, JOY Series 1000 AXIVANE Fans will give you a better, lower-cost job. Their inline, vane-axial design is lighter and more compact; and they operate more quietly, require less power and space, and save greatly on installation time and costs. What's more, you get the extra flexibility of adjustable blades—a standard JOY feature—permitting easy and quick on-the-job regulation of pressure or volume over a wide operating range, with positive protection against motor over-load. ● Whatever your job is, JOY AXIVANE Fans can show you advantages—let us work with you.

*Reg. U.S. Pat. Off.

WAD 12356

JOY MANUFACTURING COMPANY

GENERAL OFFICES: HENRY W. OLIVER BUILDING · PITTSBURGH 22, PA.

DRAVO *Counterflo* HEATERS

ALL STANDARD MODELS, BOTH GAS-FIRED AND OIL-FIRED, LISTED BY UNDERWRITERS' LABORATORIES, INC.
ALL GAS-FIRED STANDARD MODELS APPROVED BY AMERICAN GAS ASSOCIATION.
ACCEPTANCE BY FACTORY MUTUAL ENGINEERING DIVISION OF DRAVO STANDARDIZED SAFETY CONTROL CIRCUIT.
UL
FM
DRAVO

DRAVO HEATER SAFETY MEANS SAVINGS FOR YOU

Because they have this safety approval, you'll find you can obtain the lowest-possible insurance rates with Dravo *Counterflo* Heaters. These savings represent only part of the many savings you get with Dravo warm-air Heaters. For instance:

DRAVO HEATERS OFFER YOU . . .

- low initial cost . . . savings up to 60% on installation
- concentration of heat at working levels
- 150-foot air throw . . . no duct work required
- flexibility . . . units can be mounted in any position on floor, wall or ceiling
- automatic operation . . . on-off or modulating controls
- long service life . . . low maintenance . . . stainless steel combustion chamber eliminates refractory lining
- mobility . . . can be moved easily to any location
- low fuel consumption . . . direct-fired . . . burns gas or oil . . . readily converted

DRAVO HEATERS HAVE MANY USES . . .

These versatile heaters are ideal for commercial and industrial use in foundries . . . warehouses . . . machine shops . . . stores . . . schools . . . churches . . . process industries . . . and many others. Why not look into the possibilities of Dravo Heaters for your heating and ventilating needs? Write today for Bulletin No. QR-526-809

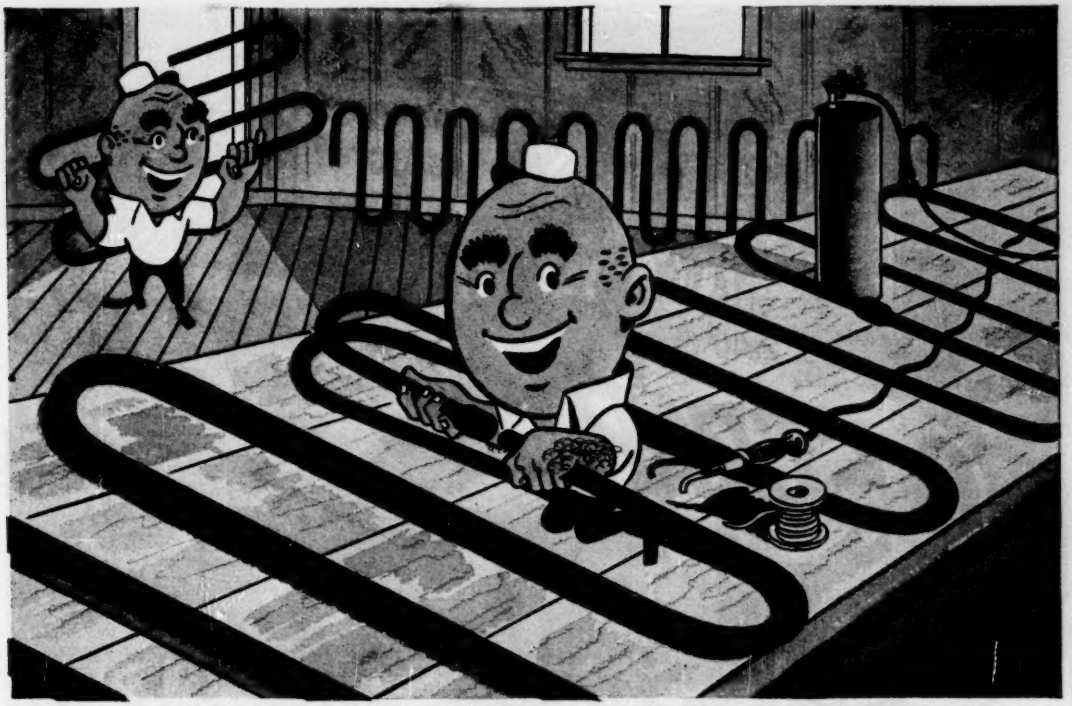
DRAVO CORPORATION

HEATING DEPARTMENT
Dravo Bldg., Fifth & Liberty Ave.
PITTSBURGH 22, PA.

ATLANTA • BOSTON • CHICAGO • CLEVELAND • DETROIT • NEW YORK • PHILADELPHIA • PITTSBURGH
Sales Representatives in Principal Cities

Manufactured and sold in Canada by Marine Industries, Ltd., Sorel, Quebec

Export Associates: Lynch, Wilde & Co., Washington 9, D.C.



Form radiant heating grids faster, too . . . with Bundyweld

NOTE that Bundyweld expanded end, above. It spells *even easier* radiant heating installation!

For twenty-foot lengths of Bundyweld Tubing can be sent to your building site with one end expanded (*if specified*). Then, one man quickly forms grid on simple fixture . . . slips unexpanded end into expanded end of the next grid, and silver brazes (or soft solders) grids into strong, permanent, leakproof union.

Two men can easily position the rigid, lightweight Bundyweld sections on ceilings or in floors. No hitches, delays. In jig time, your Bundyweld radiant heating system is all set, to the tune of a major savings in time and costs.

Bundyweld is double-walled from a single strip, copper-bonded through 360° of wall contact. It's stronger-walled, thinner-walled; bends more readily without collapsing structurally. Uniformity, even flow, maximum heat conductivity are yours!

Write today for the complete Bundyweld radiant heating story. ***Bundy Tubing Company, Detroit 14, Michigan.***

Bundyweld® Tubing

DOUBLE-WALLED FROM A SINGLE STRIP

WHY BUNDYWELD IS BETTER TUBING

Bundyweld starts as a single strip of basic metal, coated with a bonding metal. Then it's . . .

continuously rolled twice around laterally into a tube of uniform thickness, and

passed through a furnace. Bonding metal fuses with basic metal, presto—

Bundyweld . . . double-walled and brazed through 360° of wall contact.

NOTE the exclusive patented Bundyweld beveled edge, which affords a smoother joint, absence of bead and less chance for any leakage.

NO SCRAP... NO STEEL!

QUALITY
YOUNGSTOWN
SERVICE

THE iron and steel industry faces a serious scrap shortage, growing more critical every day. . . . It will be impossible for producers to make the steel tonnages demanded for rearmament and essential civilian needs, unless consumers cooperate by furnishing *more scrap*. . . Most desperately needed now is heavy industrial iron and steel scrap. . . . Keep the cobwebs from gathering at your own plant by turning in more of your own scrap today.

The Youngstown Sheet and Tube Company

General Offices--Youngstown 1, Ohio
Export Offices--500 Fifth Avenue, New York
MANUFACTURERS OF CARBON ALLOY AND YOLOY STEELS

The steel industry is using all its resources to produce more steel, but it needs your help and needs it now. Turn in your scrap, through your regular sources, at the earliest possible moment.

THERE ARE *5,750* SQ. INCHES OF HEATING SURFACE . . .

Young Type "F" Free-Standing Convector may also be installed in wall recess.

In This Popular-Size YOUNG Convector Core

Efficient heating is assured by the non-ferrous tube-and-fin heating element (illustrated)—developed by Young through a quarter-century of experience in engineering and manufacturing heat transfer products. Heating comfort is a certainty because of the quiet, steady flow of clean, draftless warmth circulated throughout the room by convection currents. Rounded cabinet corners and flanged edges, with styling that permits wall-recessing, produces a unit that is unobtrusive—one which blends harmoniously with any interior.

Versatility is yours, too. The Young Line offers a variety of cabinet styles (free-standing, wall-hung, recessed, low-level, etc.) for every rating—a type for every job. Your nearest Young Representative will gladly give you the details on special Young construction features that shorten installation time and provide complete customer satisfaction through years of use. Or, if you prefer, mail the coupon below for the Young Convector Catalog File.

YOUNG

Heat Transfer Products for Automotive and Industrial Applications.

Young Quality

T. M. Reg. U.S. Pat. Off.

Heating, Cooling, and Air Conditioning Products for Home and Industry.

YOUNG RADIATOR COMPANY
Dept. 521-M, RACINE, WISCONSIN

Factories at Racine, Wisconsin and Mattoon, Illinois
Sales and Engineering Representatives
in All Principal Cities

LEARN HOW YOUNG CONVECTOR-RADIATORS CAN CUT CORNERS ON HEATING BUDGETS

YOUNG RADIATOR COMPANY
Dept. 521-M
Racine, Wisconsin

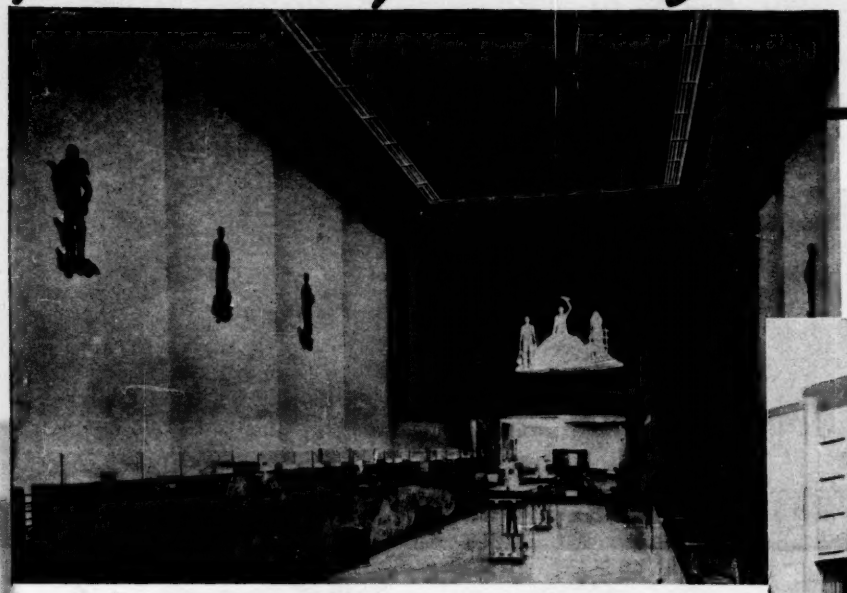
Rush me full details about the Young Convector-Radiator Line, without obligation.

Name_____

Address_____

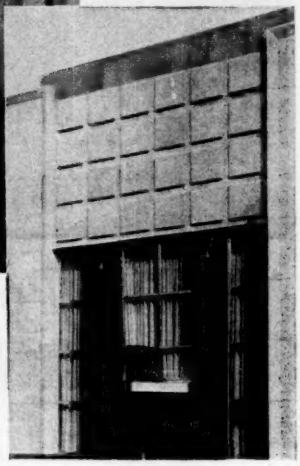
City_____ Zone____ State_____

Good Looking and Comfortable Too



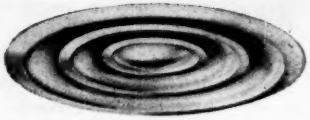
PEOPLES SAVINGS BANK
Evansville, Indiana

Architect and Builder: Bank Building and Equipment Corporation of America, St. Louis, Missouri.

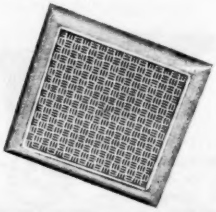


THANKS TO BARBER-COLMAN *Engineered Air Distribution*

"Good looks" are more than brick deep in this modern banking structure. Customer and employee comfort have also received the important attention they deserve. Proper air distribution is assured with Barber-Colman Line-O-Flo units. This line-type ceiling outlet can be used singly, or in continuous strips as illustrated above. For low pressure drop, low noise level, and high diffusion efficiency, Line-O-Flo is the choice of leading architects, engineers, and contractors. Line-O-Flo Ceiling Outlets are dimensionally coordinated for use with acoustical ceilings and other building products.



MODEL "J" VENTURI-FLO CEILING OUTLET— Adaptable to either flush ceiling installations or to installation on exposed ducts. Write for bulletin F-4085-1.



ADJUSTABLE SQUARE CEILING OUTLET — For acoustical tile or plaster ceilings. Available in recessed or surface types. Adjusts to any distribution requirement. Bulletin F-4728 gives full details.

BARBER COLMAN

Send for Bulletin F-2741, which gives complete performance data, dimensions, and helpful installation suggestions.

BARBER-COLMAN COMPANY, 1224 Rock St., Rockford, Illinois

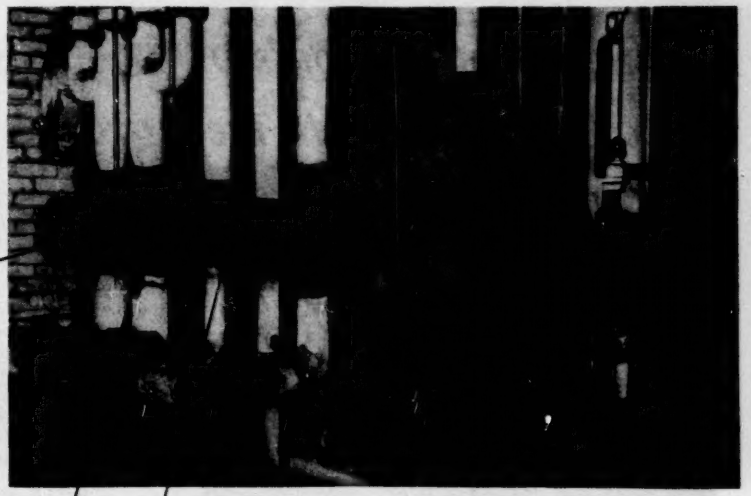
Three different temperatures

FROM THE SAME BOILER

B&G *Hydro-Flo** Heating

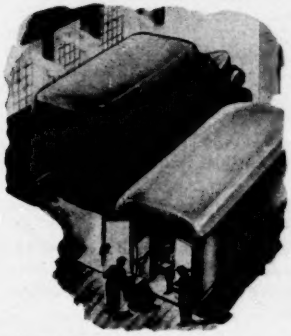
B & G *Hydro-Flo* Heating keeps offices at the proper temperature for sedentary occupations—prevents over and under heating.

72°



Worker efficiency is stepped up by B&G *Hydro-Flo* Heating. Each department can be maintained at the temperature best suited to occupational activity.

68°



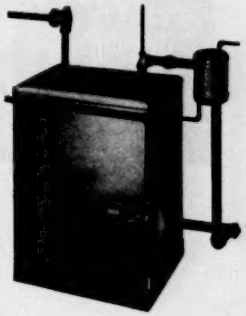
Garages and storerooms need little heat. B & G *Hydro-Flo* Heating saves fuel by keeping such areas at a comparatively low temperature.

50°

Dividing a B & G *Hydro-Flo* System into a number of heating zones permits different temperatures to be maintained in different sections of a building. The advantages are two-fold . . . greater comfort for workers at every level of physical activity and a substantial reduction in heating cost.

B & G *Hydro-Flo* Heating—a forced hot water system—eliminates the usual causes of uneven, wasteful heating. Water as a heating medium can be so closely controlled that every change in the weather is met with a corresponding change in the heat supply. Hence, indoor temperature is maintained uniformly at whatever degree is desired.

Any type of radiant heating units can be used with B & G *Hydro-Flo* Heating—baseboard panels, convectors, radiators, radiant floor and ceiling panels or unit heaters. No complex controls are required —*Hydro-Flo* equipment is amazingly simple and dependable.



For residential application

Hundreds of thousands of homes and apartments today have B & G *Hydro-Flo* Heating. This system provides radiant sunny warmth with all the economy of a controlled heat supply . . . and in addition furnishes an abundance of domestic hot water all year 'round.

Send for catalog of B & G *Hydro-Flo* Heating Products

BELL & GOSSETT

COMPANY

Dept. CH-4, Morton Grove, Ill.

Canadian Licensee: S. A. Armstrong, Ltd., 1400 O'Connor Drive, Toronto, Canada

*Reg. U. S. Pat. Off.

AIR-MAZE CORPORATION ANNOUNCES PURCHASE OF THE DETROIT AIR FILTER COMPANY

Production of Detroit's DUSTAY® disposable panels to be increased to meet growing demand

Cross-section of the Air-Maze Dustay filter panel showing how air changes direction twice, bringing dust particles in contact with the adhesive-coated cellular channels.

WITH THE ACQUISITION of The Detroit Air Filter Company, Air-Maze—which has previously manufactured only the *permanent* types of filter panels—now offers customers a choice of *disposable* filters as well, thus supplying every filter panel need.

Dustay® filter panels have had outstanding acceptance for warm air furnaces, air conditioning units and ventilating systems because they hold more dirt and last longer than other disposable types. And Air-Maze is stepping up production to meet the growing demand.

HOLD MORE DIRT—LAST LONGER

Dustay filters hold more dirt—and last longer—because: (1) they hold more adhesive—over a pound compared to only 3 to 6 ounces for most competitive makes, and (2) their cellular passages permit "depth" of dirt-holding capacity, where other disposable panels rely on surface loading.

The large amount of adhesive stored within the highly-absorbent filter cores makes possible Dustay's remarkable "wick action". As dust adheres to the collecting surfaces it absorbs the adhesive through capillary attraction. The adhesive-laden dust then becomes a medium to collect succeeding particles.

CHANGES AIR FLOW TWICE

Air changes its direction of flow upon entering the Dustay filter, then is forced to take a different direction half way through. This creates a scrubbing action which assures thoroughly cleansed air at the outlet.

Air-Maze Dustay filters provide low-cost clean air for both home and industry—in warm air furnaces, air conditioning units and ventilating systems. For full details call your nearby Air-Maze representative or write Air-Maze Corp., Cleveland 5, Ohio.

AIR FILTERS
SILENCERS
SPARK ARRESTERS

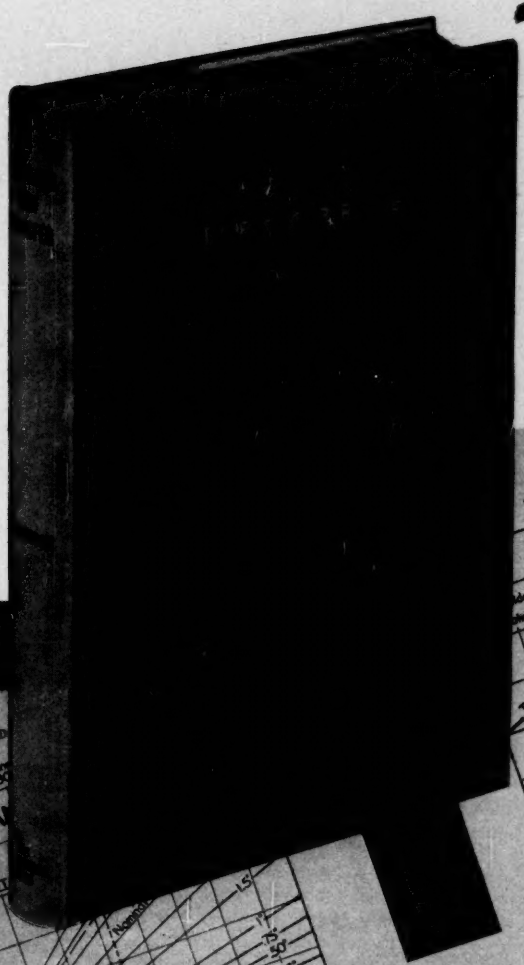
AIR-MAZE
THE FILTER ENGINEERS

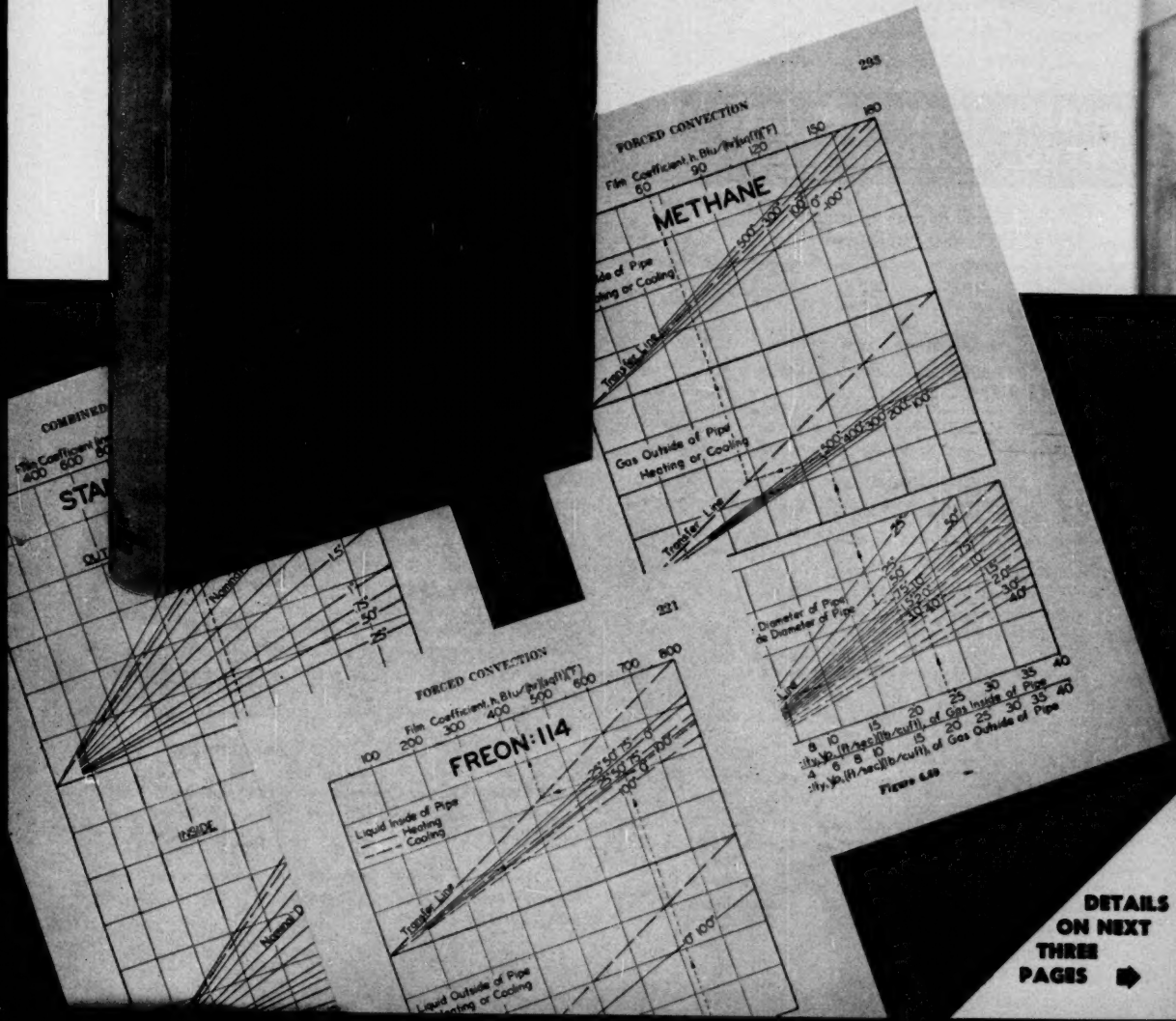
LIQUID FILTERS
OIL SEPARATORS
GREASE FILTERS

A NEW BOOK ON HEAT TRANSFER

Featuring

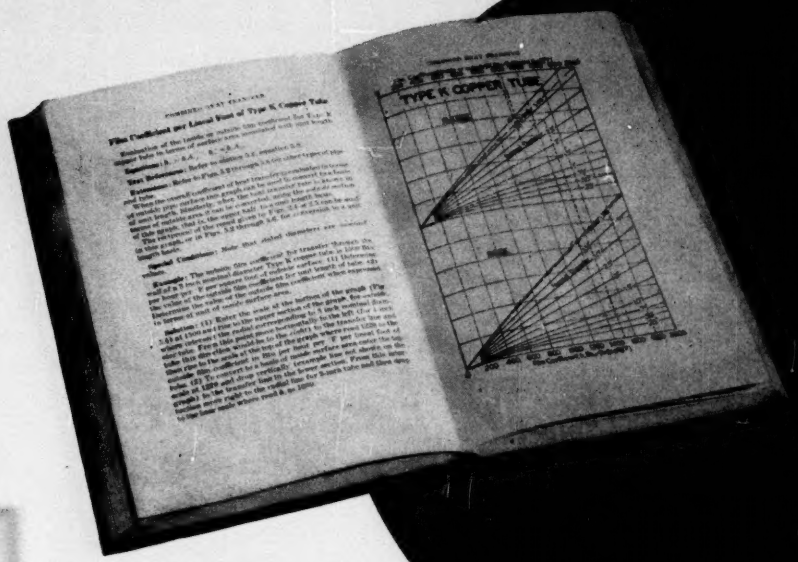
TIME-SAVING GRAPHICAL SOLUTIONS





DETAILS ON NEXT THREE PAGES ➡

A Featuring



CHARTS COVERING ALL THESE APPLICATIONS SPEED SOLUTION OF COMPLEX PROBLEMS

Graphs Relating to Conduction

Conduction through a Plane Surface
Logarithmic Mean Area, or Diameter, or Temperature Difference
Geometrical Mean Area
Thermal Resistance of Walls of Ferrous and Non-Ferrous Tube

Graphs Relating to Radiation

Shape Factor of Human Standing: with Respect to Floor, Wall and Ceiling Elements
Shape Factor of Human Sitting: with Respect to Ceiling
Shape Factors of Parallel Opposed Planes (Rectangular)
Shape Factors of Normal Rectangular Planes Having a Common Side
Shape Factor of a Rectangular Plane with Respect to a Small Area in a Parallel Plane, a Normal to the Small Area Passing through One Corner of the Rectangle
Shape Factor of a Rectangular Plane with Respect to a Small Area in a Normal Plane, the Small Area Being Cut by a Normal to One Corner of the Rectangle
Equivalent Film Coefficient, h_r, for Radiation
Net Radiant Transfer between any Two Surfaces
Equivalent Gaseous Radiation Coefficient, h_w, for Water Vapor

Graphs of Dimensionless Parameters

Reynolds, Grashof, Prandtl, and Nusselt Number Evaluations
Film Coefficient Evaluation from Nusselt Number

Graphs Relating to Free Convection, Streamline Flow, Convection with Gravity Flow and Evaporation and Condensation of Water

Newton's Law of Cooling
Viscous Liquids Heating or Cooling Inside Pipes
Water Heating during Streamline Flow in a Vertical Pipe
Water Flowing by Gravity Down through a Vertical Tube
Water Trickling by Gravity over the Outside of Horizontal Pipes
Free Convection from Horizontal Pipes to Liquids or Gases
Air: Natural Convection over Flat Plates
Conductance of Air Spaces
Air: Natural Convection over Pipes
Boiling of a Liquid: Water
Steam Condensing on a Horizontal Tube
Steam Condensing on a Vertical Tube—2 methods

Graphs Relating to Combined Heat Transmission

Overall Rate of Heat Transmission
Film Coefficient per Lineal Foot of Standard and Extra Heavy Pipe and Various Types of Copper Tube
Overall Coefficient, **U**, Based on Film Coefficients Only
Surface and Mid-Wall Temperatures of a Homogeneous Building Wall
Overall Coefficient for a Roof-Ceiling Combination
Outside Film Coefficient for Building Walls
Conductance from Inside-Wall Surface to Outside Air
Inside Air Temperature Corrected for Radiation Effects

Graphs Relating to Forced Convection: General Relationships

Liquid or Gas Being Heated or a Gas Being Cooled within a Tube
Liquid Cooling within a Tube
Gases Heating or Cooling Inside of a Tube: Approximate Solution
Liquids or Gases Heating or Cooling in Flow Outside and Normal to a Tube
Gases Flowing Outside and Normal to a Tube: Approximate Solution
Flow in Helical Coils: Correction to Basic Film Coefficient

Graphs Relating to Forced Convection of Various Liquids, Heating or Cooling, Flowing Inside a Pipe or Outside and Normal to a Single Pipe

Graphs Relating to Forced Convection of Various Gases and Vapors, Heating or Cooling, Flowing Inside a Pipe or Outside and Normal to a Single Pipe

Combined Text and Reference Book
123 Time-Saving Working Charts

A New Book for the Practicing Engineer as well as the Student of Heat Transfer

INDUSTRIAL HEAT TRANSFER provides a selective, time-saving approach to methods of heat transfer analysis. This new work by F. W. Hutchinson presents and discusses equations finding the widest industrial application, analyzes their derivation, and then brings the subject to an eminently practical conclusion by providing graphs which permit direct visual solutions of the most commonly encountered problems. Because of its unique treatment of the subject, INDUSTRIAL HEAT TRANSFER is a valuable textbook for students of heat transfer, and a useful working handbook for practicing engineers who must make accurate calculations of heat transfer coefficients and rates in designing or specifying actual installations.

A complete list of the applications which the graphs cover is shown on the opposite page. *These graphs are equal in accuracy to the equations from which they are derived.* Since many of the equations contain fractional powers and similar complexities, these direct-reading graphs not only save time, but also help to eliminate the possibility of error in calculations. As an example, consider problems involving the forced convection of liquids or gases which are heating or cooling while flowing within or outside of pipes. Analytical solutions for these cases would require the determination of viscosity, specific heat, thermal conductivity, and density—all as functions of temperature. The graphs simplify these cases by permitting direct evaluation of the heat transfer characteristics of each fluid without having to determine its physical properties. Problems covering almost every industrial heat transfer application can thus be solved—accurately—in a few minutes.

As a further aid, the page opposite each graph gives the equation, its limitations, its extension, and the references to the discussion of that equation in the text. An actual example is given, and its solution is shown on the graph. Examples have been selected which not only demonstrate the use of the graphs, but also illustrate typical solutions of heat transfer problems. The book is printed on a special hard-finish paper to permit pencil construction lines to be made directly on the pages and erased after the problem is solved.

The author is Professor of Mechanical Engineering at the University of California, and is co-author of a number of books on Panel Heating, Refrigeration, and Air Conditioning. His knowledge of heat transfer is well grounded on practical experience as well as theory, as he acts as consultant on heat transfer problems for many industrial firms. His book goes beyond a general discussion of heat transfer theory to provide the means for solving actual industrial heat transfer problems of every description. Attractively bound in durable green buckram, stamped in gold, INDUSTRIAL HEAT TRANSFER is a working reference book that will insure accurate calculations and save hours of valuable time.

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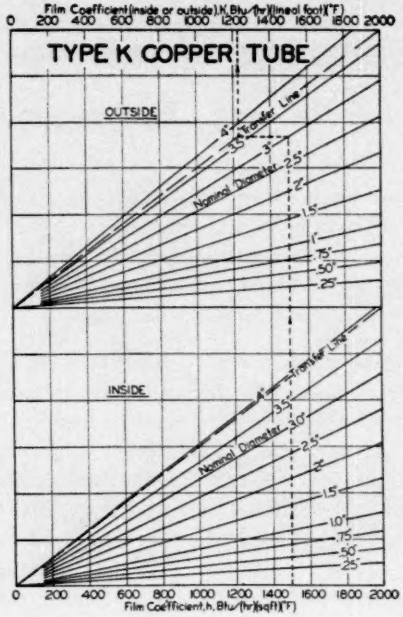

Shown below are two typical pages from INDUSTRIAL HEAT TRANSFER which illustrate how readily a complex problem can be solved graphically. The actual solution of a typical problem is described in the text and shown on each graph.

COMBINED HEAT TRANSFER

Film Coefficient per Lineal Foot of Type K Copper Tube

Evaluation of the inside or outside film coefficient for Type K copper tube in terms of surface area associated with unit length.

Equations: $h_i' = h_i A_i$, $h_o' = h_o A_o$,

Text References: Refer to section 5.2, equation 5.9.

Extensions: Refer to Figs. 5.2 through 5.6 for other types of pipe and tube.

When the overall coefficient of heat transfer is evaluated in terms of outside pipe surface this graph can be used to convert to a basis of unit length. Similarly, when the heat transfer rate is known in terms of outside area it can be converted, using the *outside* section of this graph, that is, the upper half, to a unit length basis.

The reciprocal of the result given by Figs. 2.4 or 2.5 can be used in this graph, or in Figs. 5.2 through 5.6, for conversion to a unit length basis.

Special Conditions: Note that stated diameters are *nominal* values.

Example: The outside film coefficient for transfer through the wall of a 3 inch nominal diameter Type K copper tube is 1500 Btu per hour per °F per square foot of outside surface. (1) Determine the value of the outside film coefficient for unit length of tube. (2) Determine the value of the outside film coefficient when expressed in terms of unit of *inside* surface area.

Solution: (1) Enter the scale at the bottom of the graph (Fig. 5.4) at 1500 and rise to the upper section of the graph, for *outside*, where intersect the radial corresponding to 3 inch nominal diameter tube. From this point move horizontally to the left (for 4-inch tube this direction would be to the *right*) to the transfer line and then rise to the scale at the top of the graph where read 1220 as the outside film coefficient in Btu per hour per °F per lineal foot of tube. (2) To convert to a basis of inside surface area enter the top scale at 1220 and drop vertically (example line not shown on the graph) to the transfer line in the lower section. From this intersection move right to the radial line for 3-inch tube and then drop to the base scale where read h_i as 1600.

If you are a student of heat transfer, or are engaged in practical heat transfer work, order INDUSTRIAL HEAT TRANSFER today.

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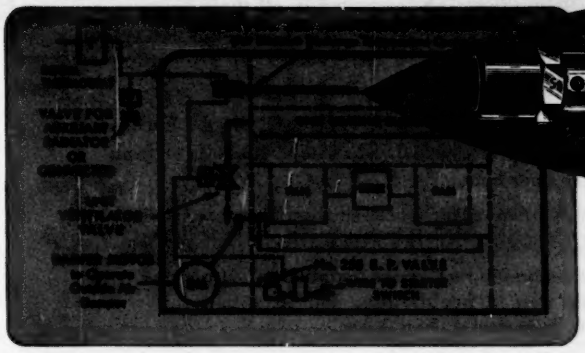

A precision non-waste type instrument requiring no auxiliary devices to supplement its accurate low limit control of unit ventilator discharge temperatures.

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Since unit ventilators operate on minimum discharge temperature much of the time it is imperative that an accurate and dependable low limit thermostat be used.

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Left: Day-Nite Thermostat with Automatic Changeover.

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(a08)

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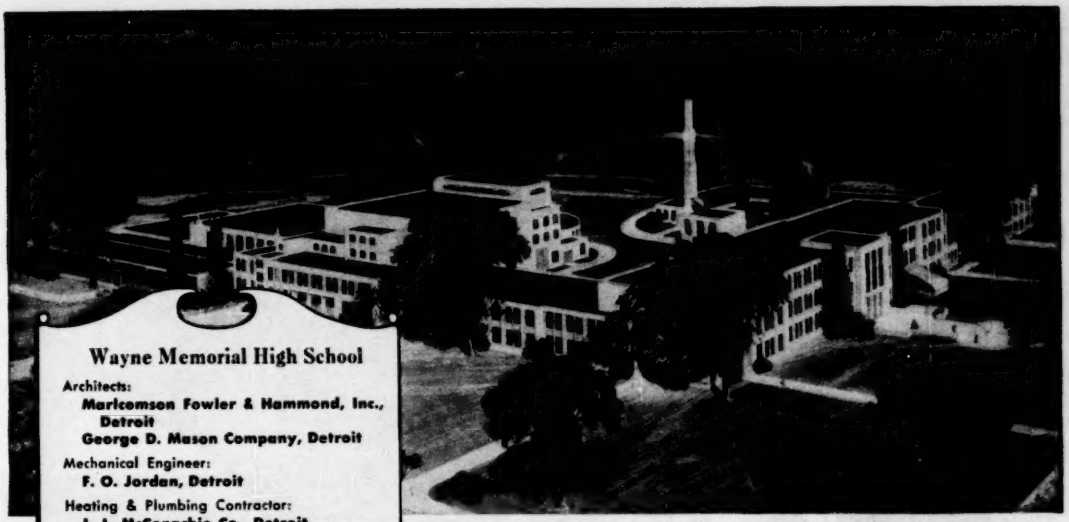


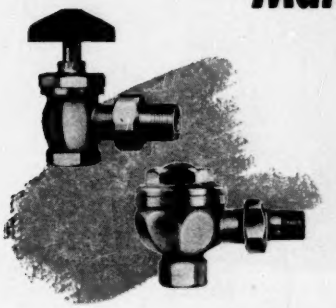
Wayne Memorial High School

Architects:
Marlcomson Fowler & Hammond, Inc., Detroit
George D. Mason Company, Detroit

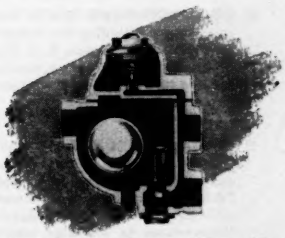
Mechanical Engineer:
F. O. Jordan, Detroit

Heating & Plumbing Contractor:
L. L. McConachie Co., Detroit

Marsh Valves and Traps Throughout



Marsh Packless Valves and Radiator Traps were chosen throughout for the Wayne Memorial High School. The most permanent packless valve construction is the Marsh metal-to-metal seal and the best team-mate for this better valve is the Marsh radiator trap.



Marsh float and thermostatic traps like this were used in the Wayne High School.

Pride of its community is this modern 3½ million dollar high school at Wayne, Michigan, near Detroit. It is a worthy addition to the growing list of model school buildings that are rising to the call of the tremendously increased number of young folks who are going in for more and more education.

Such buildings are planned and erected to become a lasting part of community activities; so it is significant that a large number of Marsh valves and traps were used in the well-engineered system which heats the laboratories, library, cafeteria, gymnasium, offices and classrooms.

But high tribute though it is, the selection of Marsh equipment here is simply one more example of the preference accorded Marsh heating specialties by foremost heating engineers and contractors in every section of America.

For your next job consider the equipment that is first choice of the most critical heating men. Write for the Marsh heating specialties catalog, 76-H, covering Marsh valves, traps, venting devices and the dollar-saving Marsh Tri-Trol regulator.

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Sales affiliate of Jas. P. Marsh Corporation
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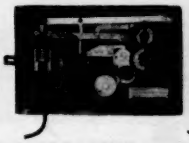
BIG FUEL SAVING WHEN HEAT REGULATION IS IN STEP WITH THE WEATHER:—



Marsh Tri-Trol is the simple, low-cost, easily installed heat regulator for multiple occupancy buildings from smallest to largest. Ask for bulletin showing how it gives ideal heating comfort at lowest cost by controlling heating in accordance with outside temperature.

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Customer comfort is an important ingredient in the shopping service offered by the Giant chain of supermarkets. That's why—*for the tenth time*—Giant Stores have turned to Marlo equipment for dependable, efficient and economical air conditioning.

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- **AIR CONDITIONING UNITS.** Three of these are providing the shopping area of the Washington, D. C. Giant Store with cooling, heating, ventilating and filtering functions—for year-round comfort.
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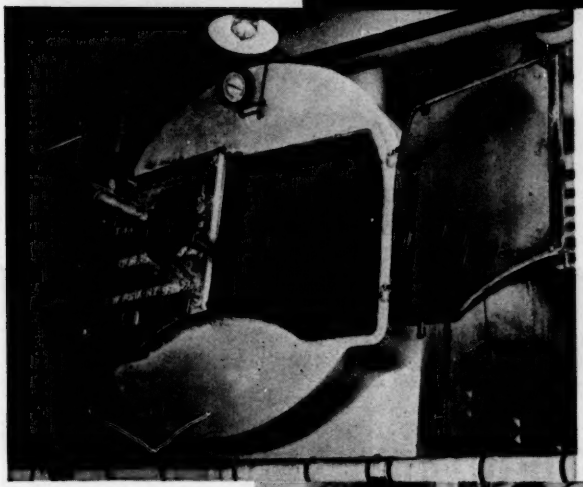
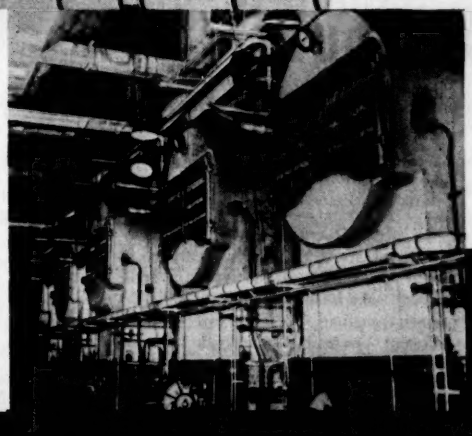


Accumulated soot in a boiler is a tremendous waster of fuel. Soot is an exceptional insulator . . . a very effective barrier to the heat. Cold rooms, higher fuel bills, general unsatisfactory operation are the result. Hand cleaning is inefficient, dirty, even dangerous.

Diamond A1E Automatic "Air Puff" Soot Blowers do a really efficient job of cleaning, without trouble, dirt, or nuisance. The boiler does not need to be taken off the line. The operator merely pushes a button and turns a valve . . . operation is automatic.

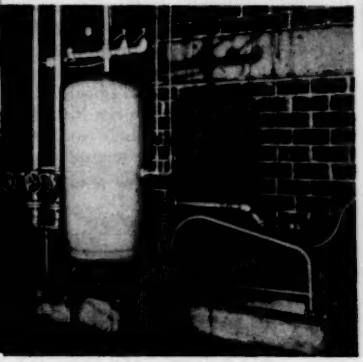
The Diamond "Air Puff" system is practically foolproof and is applicable to any number of boilers. For better heating, fuel saving, and a cleaner boiler room, investigate Diamond A1E Automatic "Air Puff" Soot Blowers. Write for Bulletin 897P.

▲ *Multi-Nozzle Element of AvE blower automatically rotates in a series of steps, blowing the entire tube bank. Cleaning is efficient—complete.*



◀ *Five fire tube heating boilers at large housing project are cleaned with Diamond Automatic "Air Puff" Soot Blowers.*

▼ *Small compressor and receiver supply all compressed air needed for battery of boilers shown at left.*



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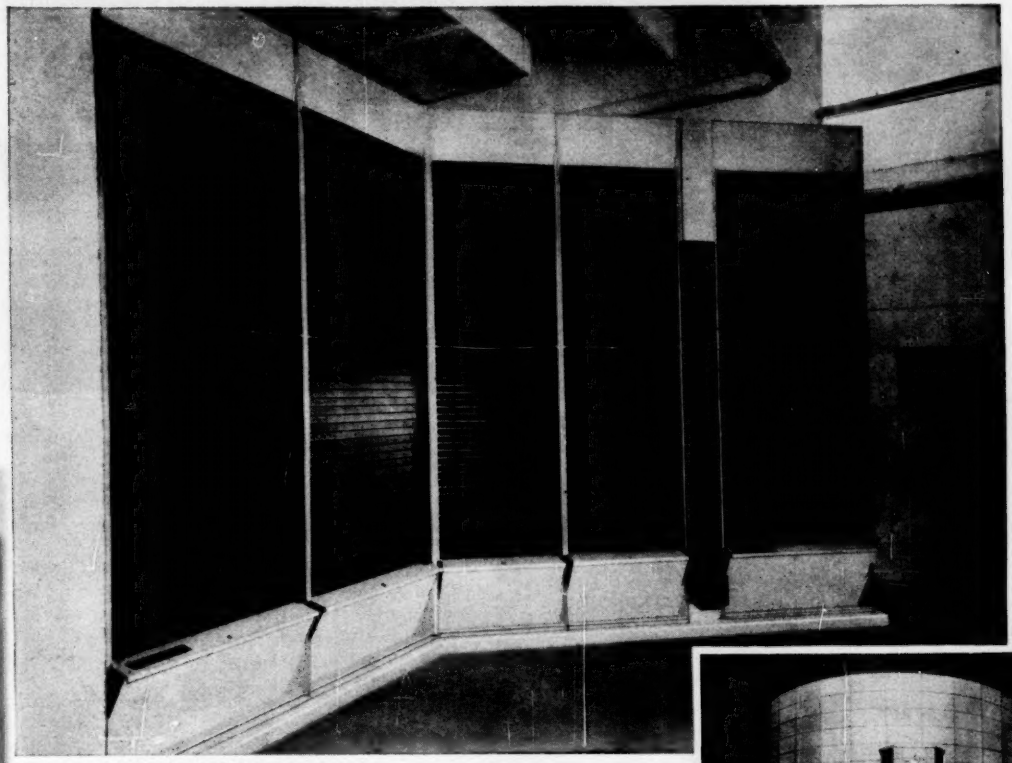

Berkley (Calif.) High School Auditorium
Architect: Henry H. Gutterson, San Francisco
Consulting Mechanical Engineer: G. M. Simonson, San Francisco
Contractor: Marelich Mfg. Co. Inc., San Bruno

AAF MULTI-DUTY

most widely used automatic air filter in the world

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The Multi-Duty automatic filter, because of its self-cleaning feature, is ideal for applications of this type where ventilating systems are not in continuous use. The filter is always in efficient operating condition without depending on the human element.

The exclusive principle of overlapping panel construction in the Multi-Duty was introduced by AAF in 1927. It is still the most practical method of combining the function of self-cleaning with the operating cycle. Although there have been numerous improvements in the design of individual panels and in unit construction, this basic principle has never been surpassed.

For detailed and illustrated description of Multi-Duty write today for Engineering Bulletin No. 241-B.

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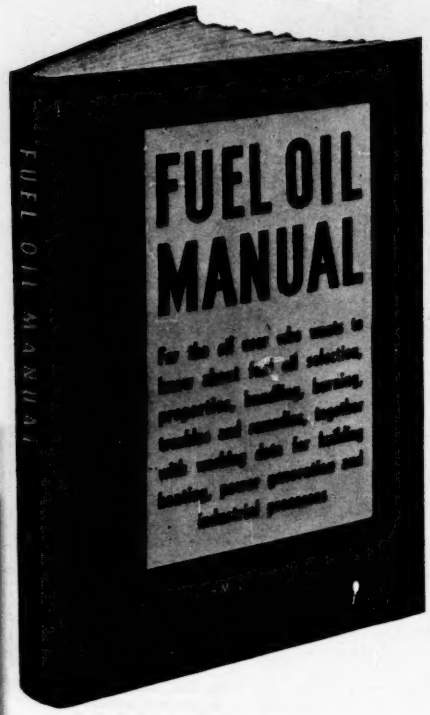

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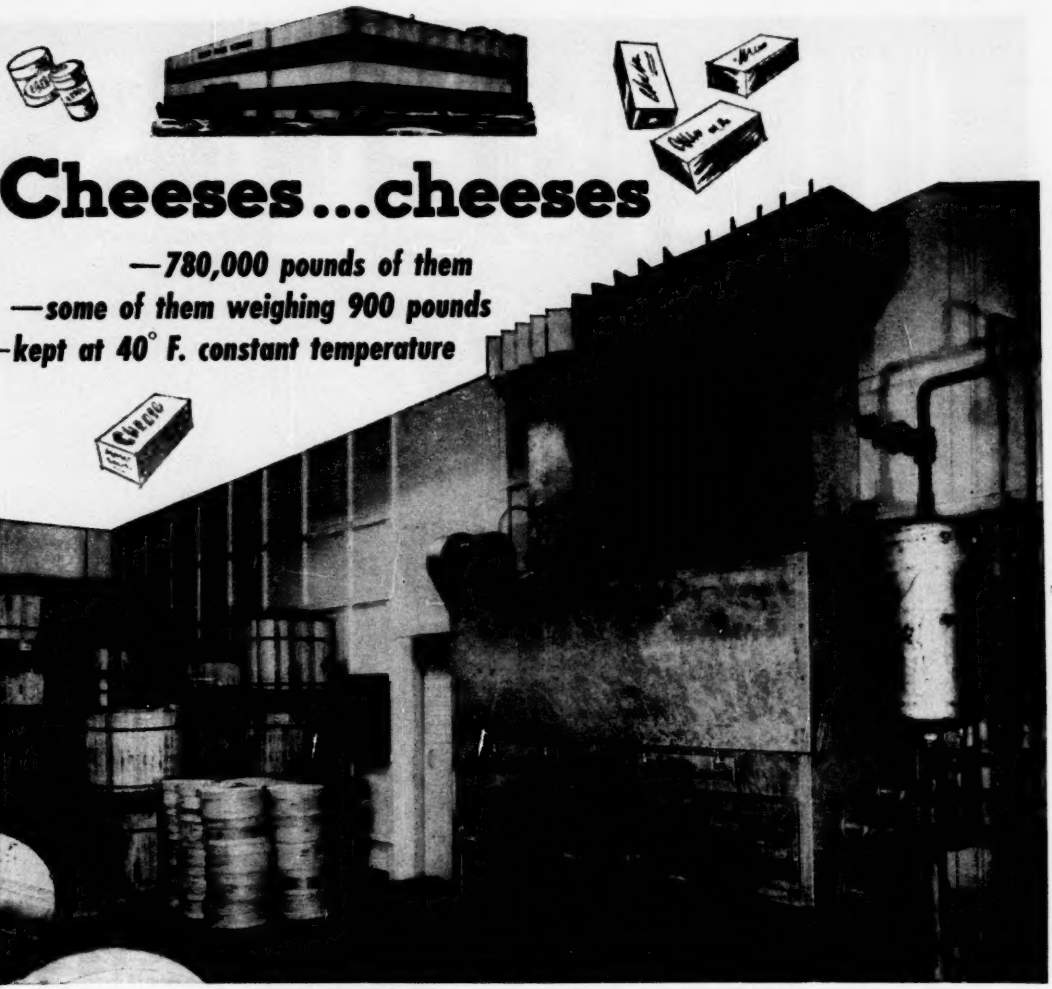

Cheeses...cheeses

—780,000 pounds of them
—some of them weighing 900 pounds
—kept at 40° F. constant temperature

At the San Francisco Plant of Kraft Foods Company, a *single ACME* Blo-Cold unit keeps the entire stocks at constant 40° F. More than three-quarters of a million pounds of Cheeses are stored in a room 40 x 60 feet. Some of the "big cheeses" weigh as much as 900 pounds. The single *ACME* Blo-Cold unit maintains a constant 40° temperature, easily and without any mechanical difficulty.

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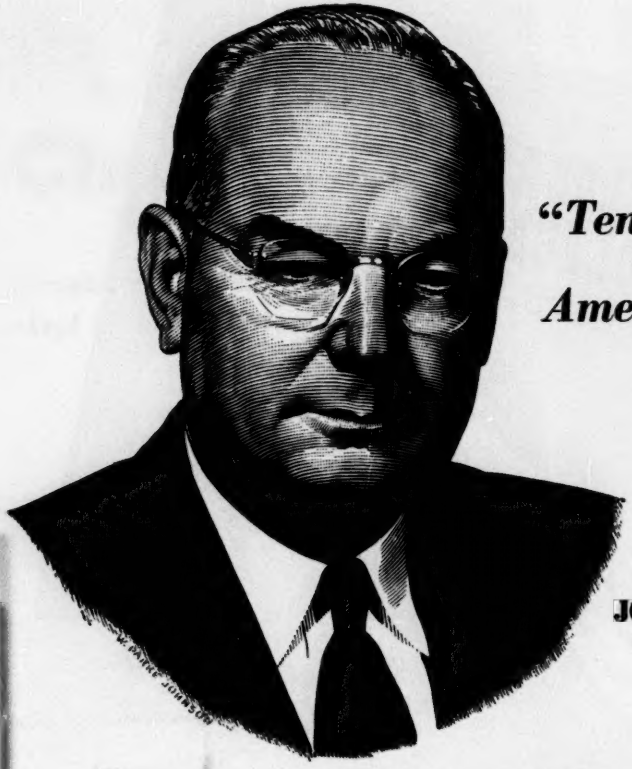

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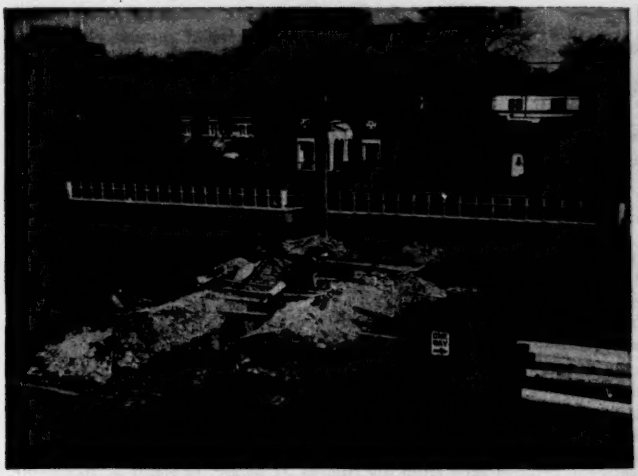
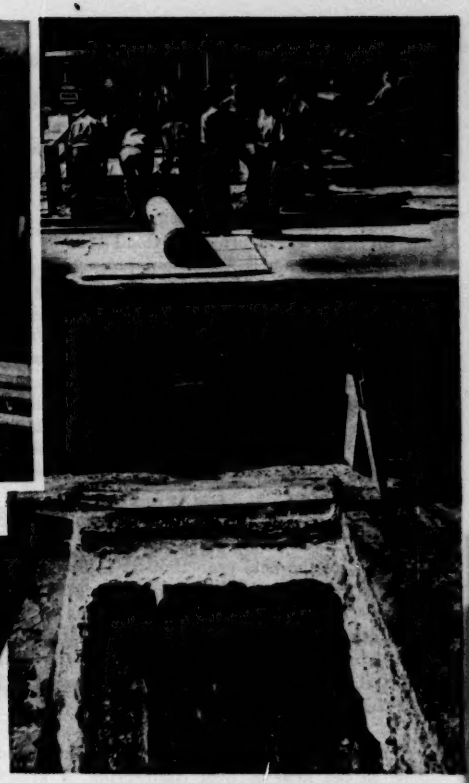


Shaker Square, Cleveland, Ohio, showing Ric-wiL Piping ready for installation under Rapid Transit tracks.

RIC-WIL INSULATED PIPING INSTALLED WITH NO TRAFFIC INTERRUPTION



Tunneling method used to install Ric-wiL pipe without traffic interruption.

One of the important requirements in the job of installing insulated piping supplying steam for heating buildings of the congested Shaker Square area was to make the installation without interruption of either rail or street traffic on the exceptionally busy thoroughfares.

By cooperative engineering and planning, Ric-wiL Prefabricated HEL-COR Insulated Piping was installed by trenching on unused portions of the area and tunneling under the rail tracks and roadways, thus permitting an uninterrupted flow of traffic.

By eliminating field fabrication of insulation and outer protection, the Ric-wiL prefabricated 21-ft. straight sections and accessories were installed quickly and economically. In the tunnel installations the units were positioned by sliding them over the lower half of existing tile as shown in the illustration above.

This fast and low cost installation demonstrates one of the many advantages found in Ric-wiL Prefabricated Insulated Piping.

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OVERHEAD

UNDERGROUND

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BRIEFLY STATED

• Shortages of materials retarded almost all types of construction during October resulting in a more than seasonal decline in activity, the U. S. Labor Department's Bureau of Labor Statistics and the Building Materials Division, U. S. Department of Commerce reported jointly. Delays in construction projects extend even to the basic steel and electric power expansion programs. The total value of new construction put in place during October amounted to about $2.7 billion, off 5% from the September total and 3% less than the total for October, 1950.

While most types of construction activity usually begin a seasonal decline from September to October, the drop this year was larger than usual. New homebuilding activity which increased slightly in October, was a notable exception to the general trend. Military and defense plant construction showed further moderate increases.

• The United States Bureau of Mines Mineral Market Report M.M.S. No. 2030, "Distribution of Pennsylvania Anthracite" for the coal year 1950-51 is now being distributed. In comparison with that for the previous year, it indicates an increase in total shipments of 306,000 tons, or nearly 1%. Excluding the decline in overseas exports from the calculations, however, the gain in United States and Canadian markets becomes 1,082,000 tons or 2.7%.

• Due to the increasing importance of mathematical methods in the field of heat engineering, a group devoted exclusively to applied mathematics has been organized under the name, Mathematical Computing Service, 105 Court St., Brooklyn 2, N. Y. Manager J. L. Miller says: Our organization specializes in performing services for industries and leading universities desiring engineering calculations of a high degree of complexity and the treatment of related mathematical problems in the field of heat engineering. An important function of our group is the mathematical formulation and complete solution of a problem from the given physical data. The staff consists of consultants holding Doctorate Degrees who are qualified to treat problems in applied mathematics related to mechanical and electrical engineering, heat conduction, radiation, thermodynamics, etc.

• York Corp. has announced the election of Donald M. Magor to the office of vice-president and controller and William F. Lynne as secretary and treasurer. Mr. Magor has been controller of the corporation since 1939. Mr. Lynne has been associated with the corporation since 1935 in the accounting end of the business. He became assistant controller in 1939, subsequently assistant secretary and secretary.

• The Economy Pump Division of Hamilton-Thomas Corp., Hamilton, Ohio, is being consolidated with the C. H. Wheeler Mfg. Co., Philadelphia, Pa., another division of the corporation. Production, engineering and sales departments of Economy are being moved from Hamilton, Ohio, to the Philadelphia plant. Economy Pumps will henceforth be known as Wheeler-Economy Pumps.

• William B. Cooper has been appointed to the newly created position of sales manager of engineered products for American Radiator & Standard Sanitary Corp. Mr. Cooper will head a new department handling the sale of air conditioning, cooling and specialized heating equipment.

• Factory sales of mechanical stokers in September, 1951, increased 5% over the number sold in August but were 19% below sales in September, 1950, according to the Bureau of the Census, Department of Commerce. Total sales of mechanical stokers during the first nine months of 1951 totaled 17,082 units, a slight decrease from the number sold during the corresponding period of 1950. Sales of stokers for residential use, small apartment houses, and small commercial-heating jobs (classes 1 and 2) accounted for 82% of the total sales during September in terms of number of stokers.

• Bituminous coal stocks at the end of September rose a little from the August 31 figure, to stand at 76,245,000 tons—¾ million tons below the June 30 peak. The owners of the above-ground stocks are, in the main, the electric utilities, the coke ovens, and general industry. At the end of September those three customer classes accounted for about 89% of the total stocks, yet they accounted for only 65% of the total U. S. consumption during the past twelve months.

• Two new executive appointments in the Airtemp Division of Chrysler Corp. have been announced. J. F. Knoff, who has been assistant general sales manager, was named general sales manager to take the place of C. S. Stackpole who recently resigned from the company. T. B. Hollencamp, former supervisor of service, was named national service manager. Mr. Knoff has been with Airtemp for six years. He joined the division in 1945 as a district representative in the New Orleans region. Mr. Hollencamp came with Airtemp in 1937 as a service representative.

• Construction's dollar volume in the 37 eastern states is likely to run 10% less in 1952 than in 1951, in the opinion of F. W. Dodge Corp.

• Election of Gerry E. Morse as vice-president of Minneapolis-Honeywell Regulator Co. in charge of industrial relations has been announced. Mr. Morse has been with Sylvania Electric Products, Inc., since 1933 and since 1948 he has been Sylvania's director of employee relations.

• President Truman appointed John J. Forbes director of the Bureau of Mines, Department of the Interior. The announcement described Mr. Forbes as "one of the world's foremost mine safety experts and an outstanding career employe in the Government Civil Service." Mr. Forbes is a native of Shamokin, in the heart of the anthracite producing region, and worked as a youth in the mines. He later received a mining engineering degree from Pennsylvania State College. He has been chief of the Bureau's Health and Safety Division since 1948, having previously served as chief engineer of the Safety Extension Service, chief inspector of the Coal Mine Inspection Division and chief engineer of the Mineral Production Security Division.

Why does "rain" often form inside roof spaces of a crowded store or school? (pages 19, 32)

Why does moisture gather on a water-and-vapor-proofed concrete floor? (page 32)

Why is it wrong to vent cold roof spaces to a warm inside space? (page 33)

Does a concrete floor slab lose heat only at the edges? (page 40)

In what direction does heat flow by Conduction? Convection? Radiation? (pages 11, 15)

Do "dead air spaces" exist with respect to heat flow? (page 16)

Why do metals radiate and absorb less heat than wood, plaster, rockwool? (pages 13, 46)

Why replace low-conductive air with denser materials of greater conductivity, i.e. ordinary insulation. (pages 11, 13, 14, 29)

The answers to these and numerous other problems of heat and vapor flow are found in the pages of the New 1951 Edition of

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By Alexander Schwartz

Written in simple language easy to understand, yet accurate and complete enough to gratify the scientist. Crammed with information the engineer, architect, public official, builder, contractor, insulator, heating installer, need. Hundreds of universities and technical schools use previous editions as a text.

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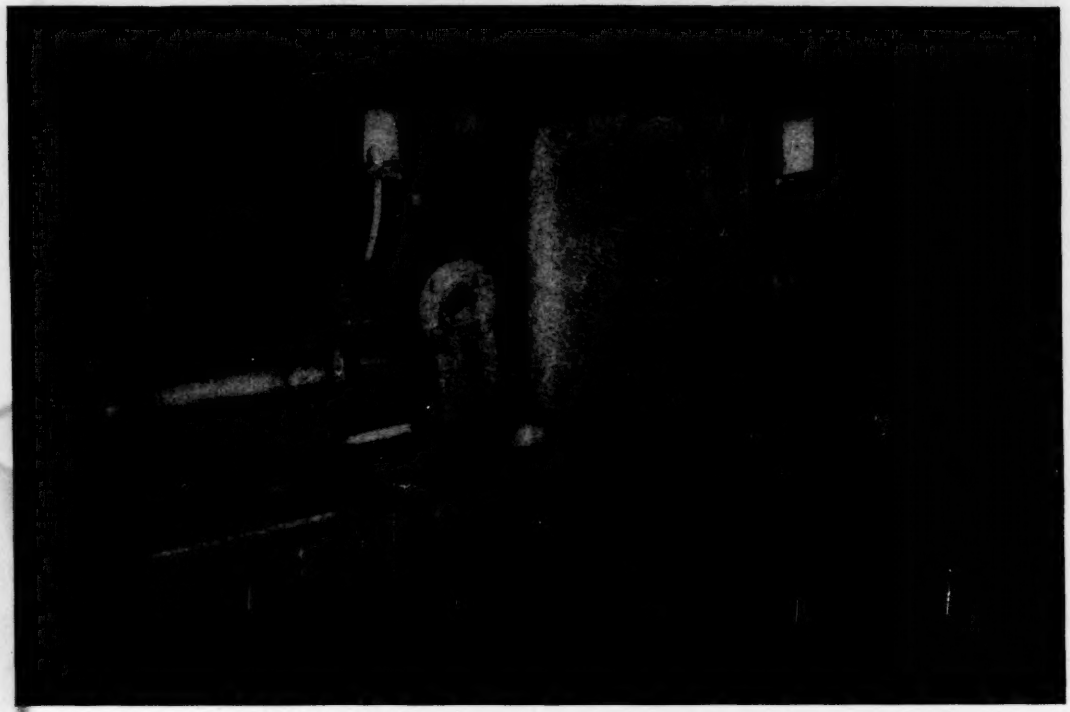

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The Jennings Condensation Pumps are sturdy and compact in construction, and combine receiving tank, pump and driving motor in a single assembly. Pumps are bronze fitted throughout, with tobin bronze shaft. The pumping impeller is of special design, made possible by our wide experience with return line heating pumps, and is especially adapted for handling hot water with the greatest possible efficiency.

Full automatic control is furnished by means of a ball float and float switch mechanism mounted on the receiving tank. All wiring is made up at the factory, and it is necessary only to connect the pump to the system and hook up the leads. Complete information regarding these economical pumps sent promptly on request.

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Unusual Refrigeration System for Low Temperature Test Chambers

W. A. BINGHAM, JR.
Engineer, Service Department, Carrier Corp.

Description of the special refrigeration system that serves two low temperature brine circuits for test chambers at the Wright-Patterson Air Force Base, Dayton, Ohio. How refrigeration and test chamber design and operating problems were solved to make system function properly is explained.

PICK out a spot anywhere on the globe. Weather conditions in that area can be duplicated in the test chambers installed in the Equipment Laboratory of Wright-Patterson Air Force Base, Dayton, Ohio. It may be the hot, arid conditions of a desert, the violence of sandstorms, rain, snow, and even fog. High temperatures and humidities can be created for the study of fungi and how they attack equipment. Besides being able to vary temperature from —125F to 250F, altitudes can be simulated from sea level to about 29.5 miles (156,000 ft).

Two Circuits Provided

The heart of the entire testing facility is the refrigeration system. A total of 800 hp develops 70 tons of refrigeration through two low temperature brine circuits. Methylene chloride brine is cooled from —118 to —125F with a flow of 570 gpm and at the same time 270 gpm of brine is cooled from 47.7 to 30F to serve the second circuit. Freon-12 is the refrigerant. Three-wheel compressors are used for each of the three stages of refrigeration.

The high stage centrifugal compressor is driven by a 400 hp, 6,600-volt, slip ring motor with manual speed control, operating at 6,750 rpm. The intermediate centrifugal compressor is powered by a 250 hp, 6,600-volt, slip ring motor with manual speed control, turning at 7,700 rpm. The low stage centrifugal compressor is driven by a 150 hp, 440-volt, slip ring motor with manual speed control, operating at 3,920 rpm.

Interstage Flashing of Refrigerant

Interstage flashing of the liquid refrigerant is allowed in each of the three compression stages of the high, intermediate and low compressor units. Interwheel flashing is employed in both the intermediate and the low stage machines. The flash gases are compressed through the last two wheels on each of these stages, which increases the economy of operation. This arrangement works equally well when the low stage is not in operation because the low temperature brine continues to be cooled in the low temperature cooler (at a higher temperature level), and the suction gas is drawn through the idle low stage compressor. A valve is so arranged in the hot gas by-pass around this compressor that when it is opened, it acts as a parallel suction line to reduce friction loss. The low stage compressor will not spin backward even when the by-pass is left closed.

Between stage desuperheaters are used to cool the hot compressed gas from the preceding stage. The intermediate-high stage desuperheater is a vertical shell in which the flashed liquid is directed against a baffle plate and the hot gas is passed through the resultant spray. This shell also contains the first high side float valve which is powered by hot gas at condenser pressure acting on a floating piston positioned by a float actuated valve port in the piston head. A hand valve has been placed in the pilot gas line to enable an adjustment of this float valve.

Float Valves

The low-intermediate desuperheater is a horizontal shell attached directly to the intermediate stage compressor suction. In this shell are the intermediate stage economizer and one high pressure and two low pressure float valves, through which the liquid refrigerant flows in series. The first float flashes liquid from the high stage suction to the intermediate stage economizer, the second float flashes liquid to the intermediate stage suction, while the third float flashes liquid to the low stage economizer. In this shell, desuperheating of the refrigerant is accomplished by a liquid spray through which the low stage discharge gas is passed. Each desuperheater has eliminators to assure dry gas to the suction of the next stage.

The low stage economizer uses an orifice instead of a float valve. The density ratio of liquid to gas is so high that an orifice is all that is necessary. A six-pass spray type cooler is used for cooling the low temperature brine. This cooler is equipped with a liquor pump for pumping the liquor from the bottom of the cooler up and over the tube bundle, thereby cooling the brine which flows through the tubes.

A flooded type cooler cools the high temperature brine. This cooler suction is also connected to the suction of the high stage compressor.

One shell and tube condenser is used to do the condensing for the entire refrigeration system. Three condenser pumps are available for circulating water through the condenser and onto a 2-section forced draft cooling tower located on the roof of the building.

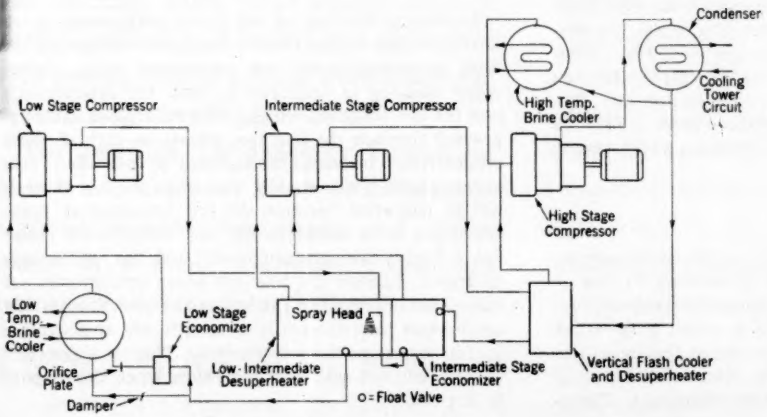
The low temperature brine is circulated by three 15 hp centrifugal pumps, each having a capacity of 270 gpm at 90 ft head. These pumps have a triple packing gland arrangement using a pressurized oil feeding system on the packing. This pressure is maintained at 4 lb above the pump suction. It is necessary to force oil into the pump packing as described, because of methylene chloride's degreasing action.

The high temperature brine is handled by three 5 hp centrifugal pumps with a capacity of 135 gpm at 60 ft head. These pumps are equipped with the same type packing glands and oiling system as the low temperature pumps.

Central Control Panel

The entire machine room is controlled from a central control panel which has all of the electrical control switches and four circular type pneumatic electronic recording instruments. Two of these instruments record and control the temperatures of both the high and low temperature brine; two instruments record the Freon-12 temperatures; three flow meters on this panel record the flow of low temperature brine, high temperature brine, and condenser water. A 16-point strip chart, located on the control panel, indicates temperatures at 16 points in the system. An indicating sub-panel, located on the main control panel, has the names of each of the test chambers with indicating lights for fan, coil and heaters, so that the operator on duty can tell when a chamber is started or whether the chamber is on a heating or cooling cycle. Several safety indicating lights are also on this control panel.

Adjacent to the machine room is a 30,000 gal Monel tank with 12 inches of Santocel insulation. This tank stores the —125F methylene chloride which is kept pressurized at 28 psi by using oil-pumped nitrogen. This is necessary to prevent boiling of the brine in some of the high temperature chambers. It is possible to charge the storage tank without using any of the test chambers, also to operate the facilities and charge the tank. When the tank reaches —125F, the refrigeration machines can be stopped, so that the test chambers can be operated for several hours using only the storage tank. During normal operation, the storage tank is never allowed to get warmer than —80F.



Schematic diagram of the refrigerant circuit showing the various compressors, desuperheaters and condensers. System serves two low temperature brine circuits.

The system is provided with a pump-down compressor, condenser and refrigerant storage tank. This pump-down unit is on automatic control, while the centrifugal machines are not in operation, and is designed to keep the entire refrigerant side of the system at a gage pressure less than 1 psig. This low pressure is necessary because of the floating type seals used on the low and intermediate compressors.

A purge recovery system, consisting of two reciprocating compressors, an oil separator, condenser, dehydrators, pressure relief valve and pilot operated float valve, is used to remove non-condensable gases. It is necessary to purge often due to the high vacuum on the system. It has been found necessary to change the dehydrator cartridges on the purge system semi-annually.

Valve and Pump Problems

Non-rising stem gate valves are placed in the nickel steel refrigerant piping where a positive shut-off valve is needed. The gate valves have parallel gates which wedge tight after completion of the gate travel. A small hole was drilled in one gate of each valve to relieve the pressure between the gates should the cold brine be warmed to a much higher temperature. If this were not done, a small portion of the liquid brine would be trapped between the gates when closing the valves. In case of a warm-up in the system this brine would start to boil, thereby creating a pressure and damaging the gates of the valves or even breaking the valve gates.

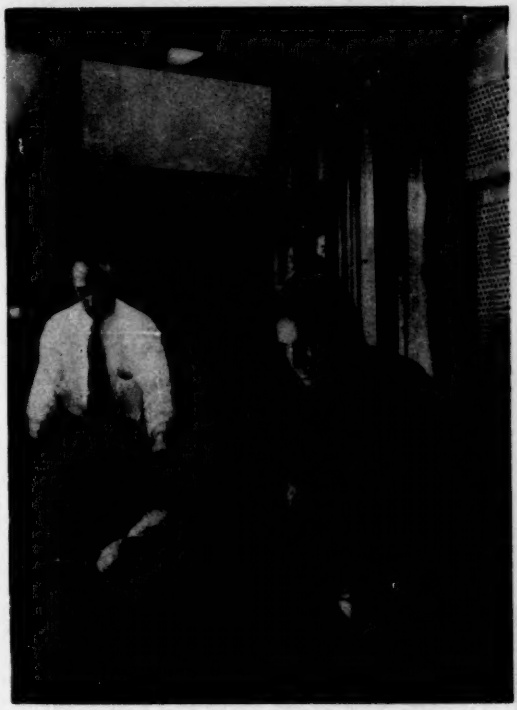
Packing in the brine pumps caused considerable trouble due to the temperature under which they operate. A number of different types and styles of packing, including plastic, were tried. None has proved successful. At present, an asbestos packing is used impregnated with graphite and oil. Oils for lubricating this packing caused considerable trouble, for most oils freeze at a temperature well above the temperatures at which the system operates. After considerable research, it was found that a hydraulic base oil made for the Air Force was the answer. By using this oil, pump maintenance was cut 50%.

Difficulty was experienced with a grease-type ball bearing running at —90F. This trouble was remedied by using a special low temperature bearing grease developed for the Armed Forces.

Brush Wear Chamber

Now for a brief explanation of the operation of the different chambers and the maintenance problems involved.

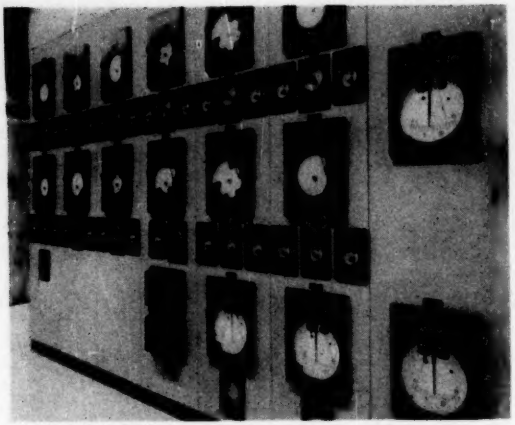
Let us discuss first the Brush wear chamber with a temperature range of 80F to —100F with altitudes up to 65,000 ft (12.3 miles) above sea level. Rotary type vacuum pumps are used to maintain altitudes and a 150 hp drive motor for the piece of equipment on test. This chamber requires more maintenance than any other chamber, because of the number of penetrations in the chamber, the large number of thermocouple leads in the chamber and the two vacuum seals—one on the main blower shaft, and the other on the 150 hp drive motor. The chief maintenance problem here is the drive motor shaft and seals. The drive shaft has 9,000 rpm maximum rotation with bearings on this shaft being subjected to extreme cold conditions and extreme high altitudes. These altitudes caused considerable trouble by pulling the oil out of the bearings through the seal and into the chamber. Oil troubles were cured by installing a shaft labyrinth to replace the seal at the inter-end of the drive housing. It was then necessary to place the entire oiling system under a higher vacuum than existed in the chamber. It was accomplished by connecting the oil cooler to the vacuum pumps ahead of the chamber control valve. Better results are obtained when placing this chamber in operation, to get required temperature conditions first before securing the required altitude. The reason is that there will be a greater mass of air with which to cool.



Conducting a test on apparatus in one of the environmental test chambers at the Wright-Patterson Air Force Base, Dayton, Ohio. View is from the inside looking toward the instruments on the outside.

All-weather Chamber

The all-weather chamber has a range of 80F to —100F. By making some minor adjustments it can be used as a high temperature humid chamber with a range of 40 to 165F and controlled relative humidity from 30 to 90%. This type chamber is not practical for use as a humid chamber because of the large amount of moisture which collects in it. When a low temperature test is run, snow accumulates on the en-



The entire machine room is controlled from a central control panel on which are mounted all the electrical control switches.

tering air grilles, making it necessary to remove this snow every few hours by sweeping the grilles.

Low Temperature and Humid Chambers

The low temperature chamber, which has a range of 70F to —112F, is insulated with 12 inches of Santocel and has eight spaces of Twindolight glass in the front. This chamber can be cycled for an indefinite period of time. In from 10 to 12 minutes the temperature can be raised from —112F to 70F.

Each of the humid chambers has a range of 40 to 185F with controlled relative humidities from 30% to 95%. The humidity is developed by steam from a steam generator using demineralized water. These chambers, insulated with six inches of Santocel, have three spaces of Twindolight glass in the front. Each has air locks so it is possible to enter the chamber while it is in operation.

One of the problems which has been encountered in the operation of chambers of this type is the maintenance of the wet bulb wicks. These wicks are located on the side wall of the chamber and are somewhat inaccessible. We find it necessary to change the wicks at least once every 120 hours of operation. Each of the humid chambers has a wet bulb control, a dry bulb control, and a brine limit control. The brine limit control is to supply a small amount of brine to the coils when the chamber is running on a hot humid cycle to prevent the possible boiling of brine circulating in the coil.

Salt Fog Chamber

The salt fog chamber is a jacketed type chamber with a range of 70 to 120F, using serpentine coils located within the jacket. This chamber is so constructed to prevent the conditioned air from coming in contact with the salt solution. In the ceiling of this chamber are four plastic trays which hold the 20% salt solution. In these trays are located four plastic float valves which control the level of salt solution. Saturated pressure air on aspirating spray nozzles lifts and atomizes the salt solution to produce the required salt fog.

It was found necessary to cleanse the walls and ceiling of the chamber with fresh water to prevent the strong salt solution from corroding the metals. Even though the chamber is Inconel lined, it has a tendency to corrode when placed in contact with such a strong saline solution.

By using a demineralizer, the mineral count of the water used in the chambers was held down to 10 ppm, while maintaining the water at a neutral pH. A 3,000 gal glass-lined storage tank under 30 lb pressure supplies demineralized water to all of the humid chambers, sun and rain chamber, and to the steam generator. It was found necessary to use this demineralized water in the sun and rain chamber to prevent the clogging of rain nozzles. This demineralizer has to be recharged every four days at the present rate of operation, using sulfuric acid and caustic soda to make the charge.

Sun and Rain Chamber

The sun and rain chamber is one of the few chambers of this type in the United States having a range of 70 to 120F. Rain water temperature has a range of 40 to 110F. Infra-red and ultra-violet lights provide the equivalent of the sun rays at the equator on the 21st day of June at noon. It is possible to cycle the lights simulating morning, noon, and late afternoon. Rainfall may be varied from 1-4 inches precipitation per hour.

Arid and Fungus Chambers

The arid chamber simulates desert conditions with a range of 40 to 220F with a low relative humidity. It is possible for a person to enter this chamber at 160F and be perfectly comfortable, just as one would be comfortable on any hot summer day when exposed to the sun.

The fungus chamber proved to be very unsuccessful. It was found that to grow fungus properly, it is very essential that air should not flow in the test space. Therefore, this should be a jacketed type chamber with very high humidity and with controlled wet and dry bulb temperature. Moisture should not be supplied by steam in the chamber but by water evaporated at chamber temperatures.

Cycling Altitude Chamber

The cycling altitude chamber is the only chamber of this type in the world. This is an experimental chamber with a range of —112F to 250F and from sea level to one millimeter of mercury in altitude. This chamber has a dry bulb temperature controller, a radiant heat controller, a brine limit controller, and high and low altitude controls. One altitude controller regulates altitudes up to 80,000 ft. At this point it automatically changes over to another controller which regulates it from 80,000 ft to one millimeter of mercury where an Alphatron is then used to get accurate altitude reading at this point. At extremely high altitudes, it is necessary to use radiant heat instead of the normal bunker heaters. These heaters consist of a

cage with calrod heaters, located around the test area. Lubricating of bearings at this extremely high altitude presented a problem which was overcome by the manufacturer using a special built oil pump and an oil cooler, the cooler being connected to the vacuum of the chamber.

It has been found necessary in the hot, humid chambers, also the hot-dry chambers, to lubricate all bearings every 24 hours with special high temperature grease. In the low temperature chamber, it is only necessary to lubricate these bearings approximately every 7 days.

All of the chambers on this job were installed by the prime contractor, the Huffman-Wolfe Co., Dayton, Ohio.

Brown Instruments Co. furnished the necessary instrumentation in the chamber and machine rooms.

Carrier Corp. supplied all the refrigeration equipment and assisted in the necessary heating and refrigeration engineering for all of the test chambers.

G. E. reactor type controls are used for all of the electric heat in all test chambers. All of the heaters in the new type chambers are low mass coil heaters to reduce time lag between the cooling and heating cycles.

Cold Batter Results in Better Crackers

A bakery nearly four city blocks in length was completed for the National Biscuit Co. at Portland, Ore. York refrigeration and air conditioning are used to achieve high production and quality control. While it has three refrigerated rooms for storage purposes in the bakery proper, the most spectacular of all the storage spaces is the 120-foot tower surmounting the building. Here are stored many of the ingredients which go into the making of the 33 well-known products baked at this plant. The temperature of the tower is thermostatically maintained the year-round at 75 to 80F, which the company officials regard as the ideal storage condition for these materials.

For more perishable products such as milk, eggs and particularly shortening, carefully refrigerated storage rooms have been provided which maintain constant temperatures.

Controlled temperatures have even been provided for waxed paper storage. When one realizes that this plant wraps up 182,050 lb of waxed paper to seal one month's production, then it is evident why the storage room has to be cooled and held at specific temperatures. Otherwise heat would cause the wax to melt, sticking the surfaces together and rendering the paper useless for the bakery's purposes.

Flour is also handled with kid gloves. It is unloaded from the railroad cars into the pneumatic tube system which sucks it up into one of the 13 steel bins located in the storage tower. Each bin has a capacity of 60,000 lb and maintains a year-round temperature between 75 and 80F. Raisins, cheese, molasses and other such perishables are stored in large refrigerator rooms, located near the rail unloading dock, where temperatures are held at 55F. This is one of the three storage areas in the bakery proper, each with its individually controlled temperature.

In the baking processes refrigeration and air conditioning really come into play. When the plant is ready to prepare an order, all ingredients which go into the making have been readied in advance, and are in proper condition for mixing. The shortening has been chilled in its storage area as have been the flour and other items such as milk, water and certain flavorings like cocoa and chocolate.

In preparing the mix for certain baked goods, ribbon ice is often used either without water or in combination with it to lower dough temperatures. A machine, capable of automatically producing daily nearly 2½ tons of ribbons, bears the ice burden. An ingredient water system employing a York ammonia compressor can lower the temperature of the Portland water used in the bakery to 33F. Maintaining proper temperatures for every ingredient going into the product is a vital step performed in the refrigerator rooms. Later in the sponge and proof rooms, temperatures are double-checked. It is in these rooms that the critical phase in the manufacture of baked goods takes place. This is the point in the mass production of crackers or cookies that makes the greatest demands on the skills and resources of air conditioning engineers.

The problem is not alone one of maintaining temperature, but also one of humidity plus control of air motion or circulation. Should any of these three factors become unbalanced, there looms the dreaded chance of many hundreds of pounds of finely prepared dough becoming worthless.

The sponge and proof room systems at the Portland plant have been created to obviate any such hazards. Automatic humidity controls, thermostats, aspirating cabinets and electro-pneumatic switches are but a few of the many sensitive, important devices which go into making these two rooms areas of an ideal weather—where not the smallest weather change can be tolerated.

Another interesting application of refrigeration to the bakery are the enrober tunnels where cookies are covered with chocolate. These tunnels, located in the icing department, are of metal lined with refrigeration coils. After being covered, the cookies pass slowly through these refrigerated tunnels where the icings settle and crisp. There are four such enrobers.

When a baked item emerges from the oven, there is still an important step vital to a well finished product —proper cooling. Each cookie or cracker as it moves from the ovens to a conveyor belt on its journey to the packing tables must be carefully cooled to permit packaging at an exact temperature. This process can no more be hurried than can baking. Each product must have its timed trip so that it reaches the packer at the right temperature for packaging.

Construct the Building Around the Boilers

T. W. REYNOLDS

In several housing projects in New York City it has been found profitable to build the structure around the boilers, so that every possible structural interference is avoided, rather than to squeeze the boilers in after the structure is in place. The author discusses advantages and savings made possible by this method and presents supporting case histories.

AS a contrast to former practice, when boilers were belatedly and commonly skidded into place through an opening left in the floor slab above or twisted through angular corridors with considerable difficulty, some interesting housing projects were completed by building the structure around the boilers. The illustrations that are part of this article show steel boiler installations for low pressure steam in several projects of the New York City Housing Authority and the Schwab House, a private project.

These projects suggest use of an unlimited number of boilers per row, in fact each of two installations, not illustrated, has 10 such boilers.

Being fully exposed, the boilers attract the critical eye of so-called sidewalk superintendents, who long since weary of looking at mere excavations, now write or phone admiring comments to the boiler manufacturer. Never before did the engineer get such a birdseye view of the boiler plant at a single glance. It is good advertising.

Figures 1 to 3 show how the boilers get there first, even before the boiler room floor is poured and steel columns erected, and well before the steel superstructure is started. There are no bulky forms for reinforced steel concrete, stored materials, or anything else to interfere.

Mechanical Contracts Awarded Early

But a few years back, a building was half erected before mechanical contracts were awarded. Now such contracts are awarded promptly, in fact almost with the letting of the general contract. This gives the contractor time to plan properly and to shop well for equipment; time to insure that machinery foundations when in will not have to be torn down to fit what later goes on them. However, the main reason for the early letting of mechanical contracts seems to be a growing realization of the importance of mechanical equipment, its ever-increasing cost, and its relation to the total cost which governs decisions as to whether to build. Percentage wise, mechanical costs are still about 25% of the general contract cost, except in certain types of large structures where better filtration, radiant heating and increased lighting are used and, in general, wherever air conditioning is included. Air conditioning costs have increased due to improved service and requirements and to better control and efficiency now common for air conditioning systems. Air conditioning costs relative to structure cost are further increased due to the fact that both air conditioning and improved engineering design of structure permit lower ceilings to be used and therefore less cubage of the structure.

As to boilers themselves, a further reason for early installation is that unit boilers permit standardization in reasonable sizes for shipment on short notice. No longer are they made to order to pack the horse-power in but one or two boilers. Often they are delivered on the job before the structural items have been fabricated in the shop. The contractor who then plans for early deliveries is sooner on the job, and sooner off, as far as the boiler room is concerned. He also receives larger initial payments on the contract, because the more costly equipment is early in place.

Results of "Getting in Ahead"

This "getting in ahead" by the heating contractor makes it a wee bit tougher, in some respects, for the builder and possibly for some of the other trades as well. To some slight extent his equipment is in their way. Operations of later arrivals are always more restricted and it is easier to find the one who damaged the mechanical equipment.

The builder and all others are helped because the heating contractor and his stored materials are quickly out of the way. Much of his equipment is soon in place for connections to be made by the electrician, plumber, and other trades. For them, final and definite positions are visible; this is better than searching for blueprints and latest job changes. Blueprints require study and are subject to error while job changes, which necessitates time to record, upset regular routine. Often they are not recorded in time to avoid errors in the field and are sometimes lost. Another advantage is that foremen will have so much more time left for other things.

Possibly the greatest help is the fact that boilers are sooner on the line for testing and therefore temporary heat becomes early available to all. To obtain temporary heat, headers with leads and breeching must be up before the floor slab above is poured. They can all be prefabricated in the shop, in section assemblies concurrent with boiler installation. By mere bolting in the boiler room, they are ready for service. Finally, for temporary heat, a gas line must be available. The quick-thinking contractor has met the lack of such service in some cases by using bottled gas. When this is used, precautions must be taken to avoid low capacity of the container in use. If empty, any connected oil burner may backfire oil vapors.

The same crane rig lowers the boiler room accessories, or as they say in the trade, "drops" them. This may be

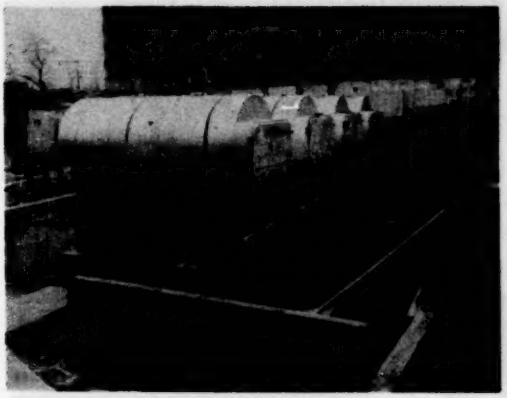


Fig. 1. Front view of the boiler plant for the Schwab House, New York City. Boilers were placed in advance of the structural work.

so because some units have had that unlucky experience. Usually, there is also a large return tank, say 8 ft in diameter and 20 ft long, and sometimes the same crane rig can be used economically to handle the oil tanks. The more equipment to be handled, the greater the justification for the use of a crane.

All considered, one contractor states there may be a one-third time saving over old ways. As he says, "I never had the time or inclination to make a study of more precise percentages, nor could I see the purpose of doing so as long as I knew it was some saving and a better procedure."

The situation is not always as rosy as pictured. Open excavations sometimes create difficulties of their own. Excavations may be too deep and difficult for big trailer trucks to negotiate so that grading may have to be done for truck entry. Recently a truck conveying a large oil tank turned over in a deep excavation. A large crane had to be worked-in to get both truck and tank out of the difficulty. However, such things are the unusual.

In low pressure steam boiler plants one can install the necessary boiler horse-power in many small standard fire-box boilers with less head room, and at less cost, even though there are multiple piping connections. Other advantages are the familiar ones of flexibility and operation, economy, operating each boiler at its highest efficiency and the ability to cut out a unit for repair, cleaning or maintenance without interruption to service.

There are many boiler units in most of the installations shown, because each boiler plant is a central plant for serving buildings of the housing projects confined to a single locality. There is economy in operation when results are compared to the 4 or 5 boiler plants otherwise required to lessen the amount of distributing pipe between buildings. While the central plant is larger, the operating force will be greatly reduced, especially so where boilers are oil-fired.

Hook up of steam, oil, and other piping, breeching, pumps, boiler controls, and like items are reduced to a minimum. Distances are less. Cubage and floor areas are also less. Still less cubage and floor area are required where 10 boilers are required, provided these boilers are not all in one row. Boilers facing one another, 5 in each of two rows, save firing space, particularly where arranged for possible coal-firing. Attention is then more centralized.

Benefits of a Central Plant

The central plant avoids duplication of related parts of the boiler plant. There need be but one spare pump or a boiler, not 4 or 5 of each for as many scattered plants. There is only one chimney, one oil tank and one excavation for it. The gage or instrument board of the central plant will be larger, but the single board will have less wiring and duplication of equipment common to such boards will be avoided. All of these items help reduce or eliminate first and operating costs that would otherwise be high.

A central plant having multiple boilers offers many like units with identical trim. These and other items can be standardized and fewer parts stocked. Servicing of like units is simpler. Like units save installation errors and make simple and quick the checking of shop drawings by the engineer and contractor. The advantage to the manufacturer who produces these drawings is also apparent.

Use of low pressure boilers in these installations has certain advantages such as safety where people dwell. High pressure requires a licensed engineer, more auxiliaries, more maintenance, more shifts, and a reducing valve at each building. It is interesting to note that projects have

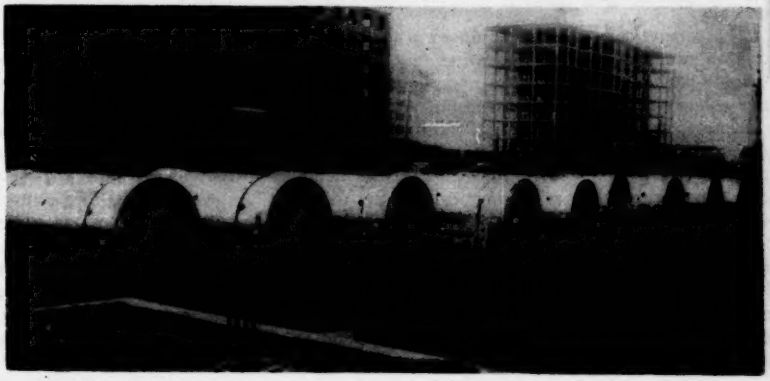


Fig. 2. Rear view of the nine boilers for the Ravenswood Houses. In the rear are some of the buildings of another housing project. All photographs courtesy of Fitzgibbons Boiler Co., Inc.

been designed with as many as 16 boilers, although this number was finally reduced as better studies were made. It is also interesting to note that the cost for a spare boiler is less of a factor as the number of boilers increase.

Fig. 1 indicates the advantage of installing boilers of this size in new building construction before the steel superstructure is erected. Here are shown the details of boiler supports and combustion chambers. Supporting brackets welded to boilers rest on brick walls to give maximum width of firebox to outside of boiler shell.

Data: Schwab House, 11 Riverside Drive, New York, N. Y., is on the site formerly occupied by the well known Schwab mansion; a private project; 4 boilers at 304 hp each; no spare boiler. Estimated population 2,500; 654 family luxury apartments; 2,220 rooms located in one H-shape building, 17 stories with total volume of 7,800,000 cu ft. It has a 200-car garage. Architect, Sylvan Bien; engineers, Sears & Kopf; heating contractors, Raisler Corp.

Fig. 2, which shows rear of boilers and part of another housing project, illustrates savings in boiler installation costs by proper preplanning before building superstructure was erected. Since the boiler room is over 100 ft long from first to last boiler, it is apparent that steel columns of boiler room would have made it difficult to maneuver boilers to their foundations had the columns and floor above been first in place. Absence of superstructure permitted easy use of a crane.

Data: Ravenswood Houses, Long Island City, N. Y. Boilers, 9 at 304 hp each. Estimated population 9,300; 2,650 apartments; 30 buildings of 6 stories and total cubage of 24,000,000 cu ft. Architect, Frederick G. Frost Jr.; engineers, Guy B. Panero, Inc.; heating contractor, Caruso-Sturcey Corp.

Fig. 3 illustrates the building of a boiler house around the boiler plant, rather than the reverse of making a boiler installation in a completed boiler house. The boilers were erected on their brick bases before any of the steel work shown had been placed. This is a separate boiler house.

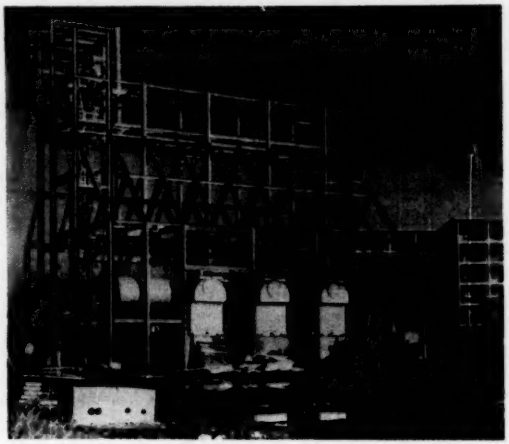


Fig. 3. Structural work of boiler plant around the boilers for Boulevard Houses, Brooklyn, N. Y.

Data: Boulevard Houses, Linden Blvd. and Ashford St., Brooklyn, N. Y. Boilers 6 (2 rows, 3 boilers per row) at 304 hp each. Estimated population 4,900; 1,400 apartments; 5,950 rooms; 18 buildings, 6 stories high with total cubage of 12,000,000 cu ft. Architects, Kelly and Gruzen; engineers, Edw. E. Ashley; heating contractor, Afgo Engineering Corp.

Step Control Cuts Air Conditioning Operation Cost

Located on the boardwalk of Atlantic City, N. J., is a new restaurant of the famous Huyler chain. A year-round Frigidaire air conditioning system provides comfortable conditions, regardless of outside temperatures. By-pass dampers are employed to insure constant air circulation throughout the restaurant at all times.

The heart of the cooling system is a heavy-duty water-cooled Frigidaire reciprocating compressor of 20 hp. Alongside this compressor is a compact, horizontal-type central system air conditioner with 24 tons refrigeration capacity.

The compressor, which is equipped with step control and an evaporative type condensing unit, provides extremely flexible and economical operation. The evaporative condenser, located adjacent to the compressor room, discharges its warm air under the boardwalk, fronting the ocean. This evaporative condenser also serves as a ventilating system for the basement. At the rear of the building, a motorized damper automatically opens when the equipment starts to operate, permitting 6,300 cfm of air to be drawn into the basement to replace air discharged from the evaporative condenser. This ventilating system, in turn, helps to remove heat given off by the battery of smaller Frigidaire refrigeration compressors which are, for the most part, combination air and water-cooled models.

While step control of refrigeration compressors is not extremely new, the application in this system is an interesting one. The large heavy-duty compressor which operates the air cooling phase of the system, is equipped to vary its capacity automatically matching the conditioning load.

A proportioning thermostat is installed in the return air duct. This thermostat is connected to a proportioning motor which operates face and by-pass dampers. As the temperature of air returning from the conditioned space approaches a point where the thermostat is satisfied, it causes the face dampers to partly close. Part of the air circulating over the cooling coil is then supplanted by air which is by-passed from the return to the supply ducts without passing through the cooling unit. This naturally reduces the cooling load on the compressor and, since the full capacity is not needed, a microswitch, operated by a cam on a shaft extension from the by-pass damper activates the step control. Two of eight cylinders of the compressor are cut out, permitting it to operate as a six-cylinder unit.

At precisely the same time the compressor change over takes place, a solenoid val.e is closed on one section of the four-section cooling unit, reducing the refrigerated coil's capacity by about 25%. This tends to give more efficient humidity control under light load conditions.

Correcting the Iron Problem in Water Systems

RICHARD B. CONLAN

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Iron in water can cause unsightly red deposits on spray heads and basins, and interference with many manufacturing processes. The insoluble form will precipitate in pipes to increase resistance to fluid flow. This article presents a general discussion of the problem and possible corrective measures.

IN many industries the presence of iron in water can not be tolerated since it reacts with reagents used in manufacturing processes. For example, in the tanning industry iron reacts with tannin to form the undesirable iron tannate. The presence of iron in water results in spotty and uneven dyeing. Iron-free water is required for processing of cotton, woolen and silk and in the manufacture of rayon. With the exception of some low grade products, the manufacture of pulp and paper is virtually impossible with the use of a water containing iron. Water containing large amounts of iron will stain plumbing fixtures and cooking utensils. Clothes laundered in a water containing iron will develop yellowish stains.

When water is first drawn, such as from a deep well supply, unaerated water containing iron is clear and colorless. After aeration, or on standing exposed to the air, the water develops a milk-like haze and later a yellow to reddish-brown precipitate of iron (ferric hydroxide). Iron in excess of 0.5 ppm is usually considered objectionable for industrial use.

Iron in water will fall out and will deposit in distribution systems thereby increasing the frictional resistance to flow through the pipes. It may interfere with operation of water meters, and may clog cooling systems, spray nozzles, pumps and other equipment. When the water is used in heat exchange equipment, such as ammonia condensers, the iron may become another potential scale-forming constituent. This fact is also true when the water is used for boiler feed purposes.

Removal of Iron

Two basic methods may be used for removing iron from water: (1) direct oxidation and filtration, and (2) chemical treatment and filtration. The methods are similar inasmuch as each depends upon the conversion of iron to an insoluble form with subsequent removal by filtration. However, in method (1) oxygen is used directly to precipitate the iron while in (2) iron is converted to the insoluble form by means of commercial chemicals.

The two basic methods of iron removal may be further subdivided into the more common individual methods of treatment. The basic method of direct oxidation and filtration would include (a) aeration, settling and filtration and, (b) contact filtration.

Aeration, Settling and Filtration

In this process the water is first aerated by intimately admixing water and air. Oxygen added to the water by aeration either through open or closed type aerators, converts the iron to the insoluble form and the iron is precipitated as ferric hydroxide. Coke tray aerators are widely employed for iron removal although other open type units may be used such as slat tray, splash, or spray type aerators. The process may be carried out in (1) closed pressure type units, (2) closed type degasifier, or (3) forced draft aerator. In type (3), air is blown counter-current through the water which trickles down over the slats and much less space is required than for open type units.

While the insoluble ferric hydroxide produced by aeration may be removed by settling or by filtration, generally both steps are employed. When the amount of iron to be removed is small, the load imposed on the filters will be light and possibly settling may not be necessary. If the iron content is high, the retention period in the settling basin should be long enough to permit the greater amount of precipitated iron to settle out, thus reducing the load on the filters. For filtration, standard pressure or gravity type units may be used, employing either sand or anthrafilt (fine coal) as the filter medium.

Although aeration may be used directly, it is most favorably employed in conjunction with other methods since simple aeration is not always sufficient to effect satisfactory iron removal. While 1 ppm of oxygen will precipitate 7 ppm of iron, the reaction is slow for waters of low pH value. The reaction may be speeded by increasing the pH of the water through the addition of an alkali such as lime or soda ash. As an alternative to aeration, the direct addition of oxidizing agents to a water supply will convert soluble iron to the insoluble form. Permanganates, hypochlorites or chlorine may be used for this purpose.

When water contains both organic matter and iron, it is extremely difficult to remove the iron. This water is not satisfactorily handled by the usual aeration, settling and filtration processes. While chlorination is of value, it is usually necessary to employ coagulation, followed by settling and filtration. The coagulant most widely employed is alum although it is necessary to conduct tests to determine the most effective and economical coagulant for each particular water.

Contact Filtration

In this method of iron removal, oxidation and filtration are accomplished in one step. A certain portion of the soluble iron present in ground waters may be removed

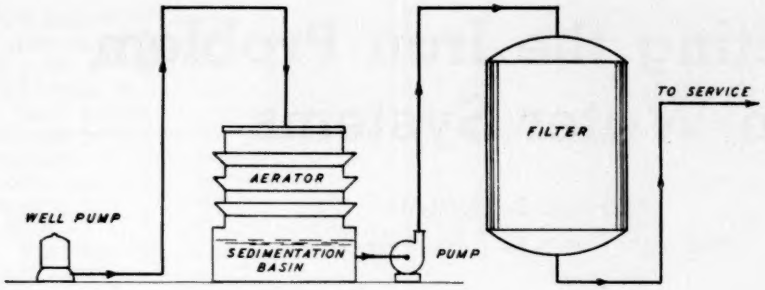


Fig. 1. Iron removal by aeration, settling and filtration.

on contact when the water is passed through a bed of porous materials such as coke or broken lava. The material on becoming coated with the precipitated iron oxide promotes a catalytic precipitation of soluble iron from the incoming water. The contact filter beds which are commonly employed are manganese coated sand, pyrolusite (manganic oxide), manganese zeolite or Birm (a patented black granular filter product). The materials may be installed in a standard filter of either the pressure or gravity type.

The materials constituting contact filter beds either supply the oxygen necessary to oxidize the iron or act as a catalyst between the iron and the dissolved oxygen content of the water. Filter beds supplying oxygen become exhausted in time and must be reoxidized or regenerated. Filter beds that act as catalysts between the dissolved oxygen and the iron in the water do not generally become exhausted. The accumulations on the bed may be removed by periodic backwashing.

Iron removal by this method is subject to limitations of pH range, hydrogen sulfide content and organic matter present in the water to be treated. A certain relationship is required between the dissolved oxygen content and the iron content of the water. The method has application where the iron content of the water is not excessive, or where it may be desirable to treat the water under pressure.

The basic iron removal method of chemical treatment and filtration may be subdivided to include (1) lime treatment, (2) lime-soda ash softening and (3) cation exchange.

Lime Treatment

Iron is precipitated as ferric hydroxide by the addition of lime in amounts sufficient to neutralize the carbon dioxide present in the water and to maintain a sufficiently high pH value. Iron may also be precipitated with caustic soda or soda ash. Treatment with either of these materials may be preferred where the corrected water is to be used for boiler feed purposes, since the addition of lime increases the hardness of the water.

Aeration is frequently employed prior to lime treatment and the type aerator used will depend upon the carbon dioxide content of the water. Usually the aerator is located over the lime treating equipment. As the pH of the water is increased by the feed of lime, oxidation of iron is very rapid. Newer designs in equipment allow precipitation, flocculation and sedimentation to take place in one unit. Turbidity from this type unit is generally sufficiently low to permit the use of the treated water without filtration. However, where complete removal of even traces of iron is important, filters should be used.

Lime-Soda Ash Softening

Iron removal is accomplished by either hot or cold lime-soda ash softening, in the same manner as described. This method of iron removal finds its most favorable application where a water contains iron in addition to objectionably high hardness. Iron is precipitated as the insoluble ferric hydroxide and is removed by the filters in conjunction with the softening operation. In cold lime-soda ash softening, aeration is employed prior to the treating equipment as described. Heavy precipitates from the softening action, as well as the precipitated iron floc, settle out before filtration. Usually the addition of a coagulant to effect settling is not required. Also, where slight turbidity and traces of iron can be tolerated in the treated water, the use of filters may not be required.

Cation Exchange

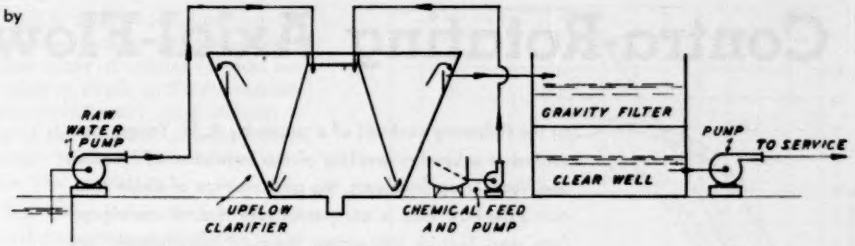
Under certain conditions, cation exchangers operating on either the sodium or hydrogen cycle may be employed for removal of soluble iron from water. Removal of iron is similar to removal of calcium and magnesium in softening. Zeolites may be of green-sand, carbonaceous or synthetic resin types. Iron is removed from the zeolite mineral in the same manner that calcium and magnesium are removed on regeneration of the exchange mineral.

This process is usually applied to waters of limited iron content and all the iron should be in the soluble state. Should aeration occur prior to softening, ferric hydroxide will be precipitated and will foul the zeolite bed. Fouled beds of carbonaceous zeolite may be cleaned without harm by inhibited hydrochloric acid. Green sand is affected by acid of sufficient strength to dissolve ferric hydroxide.

Retention of Iron in Solution

For some applications, such as once-through systems, the presence of iron in water may not be objectionable so long as the iron remains in solution. Iron dissolved in water may be stabilized and its precipitation prevented by the use of surface active agents, such as complex phosphates and organic compounds. The iron is retained in solution through the formation of a complex between the surface active agent and the iron. The use of the proper complex phosphate or organic surface active agent will prevent precipitation of iron even when the water is exposed to air, increased in temperature, and subject to chlorination.

Fig. 2. Iron removal by lime treatment.



Difficulty due to iron deposits may be experienced in heat exchange equipment such as ammonia condensers, particularly those containing steel tubes. Deposits can be due to precipitation of iron present in the water. This condition can be corrected by the feed of a complex phosphate or surface active organic agent to retain the iron in solution and to prevent its precipitation in the equipment and lines.

Corrosion may occur in the heat exchange equipment or in the lines to this equipment through the use of a water of low pH value or relatively high dissolved oxygen content. Deposits of corrosion products would give rise to difficulties in these units. This condition can be relieved or corrected through the feed of a complex phosphate or organic surface active agent. These materials exert a dispersing action on iron deposits, both products of corrosion or iron that has been deposited from solution. When applied to a system where the iron deposits are quite heavy, the deposits may slough-off after treatment is applied and in such cases it is advisable to flush-out the system frequently. Continued treatment will maintain iron in solution and will prevent the deposition of corrosion products. These materials may also be used in cleaning water wells when iron deposits have accumulated in the well casing and the well strainer.

The selection of the particular complex phosphate or organic surface active agent and the quantity to be fed depends upon a number of factors. These include the chemical characteristics of the water, length of time the iron is to be retained in solution, temperature of the water and the amount of aeration to which the water is subjected. For optimum results in iron retention, the treatment should be fed in proportion to the flow of water. The treated water will develop a slight yellow color due to the formation of the iron complex although this will not be objectionable for most applications.

Iron Bacteria

The presence of iron bacteria may also be encountered in iron-bearing waters. These filamentous organisms are not true bacteria but represent a somewhat higher form of plant life. They are characterized by the presence of iron on the surface or within their gelatinous sheaths. The most common of these organisms is known as crenothrix (crenothrix polyspora) although the term iron bacteria also includes gallionella ferruginea, spirophyllum ferrugineum, cladothrix dichotoma, leptothrix ochracea and clonothrix fusca. While growth of these organisms will cause clogging of service mains, nozzles, meters, pumps and filter beds, decaying masses give rise to disagreeable tastes and odors in the water. Iron bacteria develop in clumps or as slime attached to the walls of distribution pipes and restrict flow. They may be present in springs, wells, reservoirs and in stagnant ponds.

Although the presence of organic matter is necessary for their growth, light and oxygen are not essential since some organisms are prominent in dark waters deficient in oxygen. While the organisms exist almost entirely in iron bearing water, the growth of certain species is supported in iron-free water. Carbon dioxide favors growth of iron bacteria and some species take up manganese as readily as iron.

Since an accumulation of iron bacteria is undesirable, the condition can be corrected by removing iron from the water before it enters a distribution system, thereby depriving the organisms of food. Removal of organic matter is also advantageous and an increase in the dissolved oxygen content of the water in excess of 2.0 ppm has also proven an effective method in the prevention of these growths.

Growth of iron bacteria may also be prevented by the use of chlorine or copper sulfate. Chlorine in sufficient amounts to maintain a residual of 0.5 to 1.0 ppm has been effective and satisfactory results have been reported when 0.3 to 0.5 ppm of copper sulfate is applied continuously for several weeks. If the growths are to be destroyed rapidly, copper sulfate dosages above the limit for potable water supplies are required. The continued feed of 0.15 ppm of copper sulfate will prevent growths of iron bacteria.

Conclusions

Difficulties encountered with staining of fixtures, clogging of lines and condensers with precipitated iron may be remedied in several ways. Dependent on the source of the iron and the characteristics of the plant system, one of the several methods of iron removal may provide the most suitable treatment. However, it may be more economical to avoid the installation cost of an iron removal system and instead, to retain iron in solution with the use of surface active agents. If iron bacteria are the source of the iron deposits, then chlorination, aeration or copper sulfate treatment is advisable. Usually, the measures taken to control the iron problem will also satisfactorily prevent manganese difficulties, due to the similar characteristics of iron and manganese.

In some cases, iron deposits are caused by corrosion of the system and are not related to the iron content of the raw water employed. Since the proper solution to any iron problem requires that the source of the deposits be definitely identified, treatment measures should not be adopted until a complete survey of the problem has been conducted by qualified engineers. Without such a study, difficulties may result.

Contra-Rotating Axial-Flow Fans

In the following abstract of a paper by R. H. Young, presented at a London meeting of the Institution of Heating and Ventilating Engineers, the performance of single rotation axial-flow fans is compared with that of centrifugal fans, and factors influencing pressure development are reviewed. Gradual development of the contra-rotating fan is traced and the reasons for its high pressure development explained. Applications of contra-rotating fans are discussed.

WHILE use of the axial-flow fan has increased through the past twenty years, those produced have largely conformed to a few standard arrangements, and new developments have been confined to use of guide vanes, enclosures, and similar accessory treatment not involving new application of aerodynamic principles. While the axial-flow compressor has required a modified aerodynamic approach, it is not primarily concerned with the propulsion of air and is therefore not classed as an axial-flow fan.

The use of contra-rotating impellers in axial-flow fans, on the other hand, involves an extension of aerodynamic treatment and introduces almost as many variables as are met with in design of centrifugal fans.

Axial-Flow Design

A study of any of the published works on the subject will show that pressure development in an axial-flow fan depends on the lift force of an aerofoil moving in relation to air. While small pressure rises can be obtained by the introduction of downstream guide vanes, the pressures obtained with axial-flow fans can never approach those obtained by centrifugal fans at similar peripheral speeds. For comparable pressure development, tip speeds of the axial-flow fan must be increased to a point where noise becomes a factor inhibiting their selection for many uses.

In addition to upstream and downstream guide vanes and Venturi inlets and outlets, one of the important factors in pressure development of axial-flow fans is tip clearance. Pressure development can increase appreciably with reduction of tip clearance, and a comparison of groups of fans identical apart from tip clearance shows that decreasing clearance from ⅛ inch per foot impeller diameter to 1/32 inch increases the static pressure development just prior to stall by 20% in the case of the non-guide vane fan, by 33% in the downstream guide vane fan and by 52% of the upstream guide vane fan.

For the single rotation fan the only other variables affecting pressure development are blade form, hub ratio, number of blades and solidity.

Contra-Rotating Impellers

One of the earliest contra-rotating units was the marine torpedo propeller. While it was adopted mainly to overcome torque reactions, it has several advantages which led to its adoption in at least one surface vessel. A study of contra-rotating aircraft propellers showed that apart from the elimination of slipstream and gyroscopic effect on control, the use of contra-rotating propellers makes possible a saving of 30% in propeller diameter, an overall saving in propeller weight and an increase in propulsive efficiency from 1 to 13%.

Early work on contra-rotating fans is credited to De Bothezat in the United States and Poole in Great Britain. Toward the end of World War II a British manufacturer, faced with the problem of providing a light, compact and efficient fan for use in aircraft, developed contra-rotating fans for this purpose. These fans were soon followed by some 36-inch units supplied for use with boilers. The normal operating static pressure for these fans was 3.5-inches w.g.

Theory and Design

The simplest expedient of using two oppositely pitched and oppositely rotating, but otherwise identical, impellers does not result in a very efficient or satisfactory relation. A study of vector diagrams shows that the downstream impeller fails to balance the velocity of whirl of the upstream impeller. The direction of whirl is reversed and the kinetic energy represented by the rotational component of the final discharge is lost.

A second point of interest is the increase of apparent angle of attack by the downstream impeller. This may result in a condition where an angle of attack on the upstream blade of 5 degrees would be balanced by a 9-degree angle in the downstream impeller. As a result, the stall point on the downstream impeller may be reached before the angle of attack on the upstream impeller has reached its effective maximum value.

Angles of Attack

It should be noted that the angles of attack mentioned are not true angles of attack but are those effective angles resulting from rotational interference.

In spite of its shortcoming, this simple arrangement results in an appreciable pressure development when compared with that of single rotation fans.

An obvious step to limit the angle of attack on the downstream blades is the adoption of lower pitch angles

of these blades. When this is done, it is found that the pressure developed is increased because with the modified arrangement, much higher values of velocity of whirl can be obtained before the angle of attack on the downstream impeller reaches a value which would cause stalling. A more important feature of the modified arrangement is the gain in overall efficiency resulting from a lower rotational component of the final discharge.

In a single rotation fan, the angle of attack is limited by the approach of the velocity pressure developed to the theoretical total pressure. Thus for a pitch angle of 41 degrees, 30 minutes, the total pressure developed by a single rotation fan would be entirely used up by velocity pressure and leave no margin to cover internal fan losses or external static pressure. On the other hand, the total pressure developed by the contra-rotating unit will provide an appreciable surplus over the pressure necessary for the acceleration of air, even with upstream pitch angles of 45 degrees.

When the relationship of angles of attack and pitch angles for pairs of impellers is studied in the light of vector diagrams, it is notable that for any given combination of pitch angles there is only one value of angle of attack in the upstream impeller and one value for the downstream impeller which will result in true axial discharge. However, tests show that operation over a fairly wide range on either side of the design point can be quite efficient and the accompanying small velocities of whirl on final discharge are normally of little consequence.

Other Variables

Another method of obtaining final axial flow and operation at high efficiency is by adoption of a varying annulus. This can be done either by reducing the fan casing between two impellers or the somewhat similar arrangement of increased hub diameter on the downstream stage.

A further arrangement which has definite advantages but which in practice, assuming direct a.c. electric drives, is limited to large size, low rpm machines, is the use of two different motor speeds. Provided suitable speeds are available, two impellers of generally similar design may be used to obtain true axial discharge while ensuring the same angle of attack on the blades of each impeller at the design duty. With such arrangements, the tangential velocity of the upstream impeller should be equal to the sum of the tangential velocity of downstream impeller, plus the velocity of whirl of the air stream. In general, the upstream impeller speed in rpm would be from 15 to 20% above that of downstream impeller.

Total Pressure Developed

The contra-rotating fan is shown to develop a total pressure twice that of the comparable single rotation fan with guide vanes. That is, the total pressure (FTP) of the contra-rotating fan is equivalent to that of two upstream guide vane fans having blade angles equal to the blade angles of the downstream element in a contra-rotating fan or to two downstream guide vane fans having blade angles equal to that of the upstream element in a

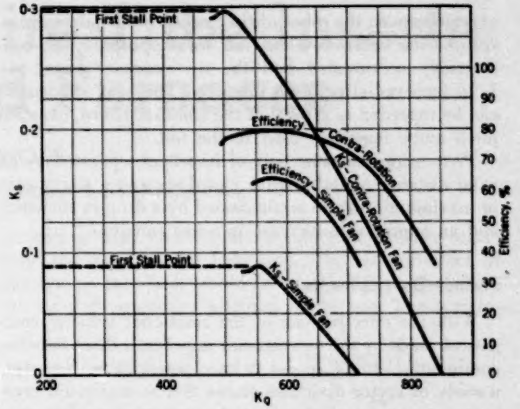


Fig. 1. Comparison of simple fan and contra-rotating fan in terms of Ks and Kq representing static pressure and cfm respectively of a hypothetical, 1 ft diameter, 1,000 rpm fan.

comparable contra-rotating fan. Since static pressure (FSP) is a better indication of useful pressure, a practical comparison of the contra-rotation and guide vane fans is obtained thus:

$$FTP_{CR} = 2\ FTP_{GV}$$

$$FSP_{CR} + VP_{CR} = 2\ FSP_{GV} + 2\ VP_{GV}$$

—and for equal volumes and, therefore, equal velocity pressures (VP):

$$FSP_{CR} = 2\ FSP_{GV} + VP$$

This expression is in general agreement with the principle that with any normal form of series operation or multi-staging (where there is no interaction due to velocity of whirl), the fan total pressure of the combination is twice that of the individual units, and the fan static pressure of the combination is equal to twice that of the individual units, plus a further static pressure equal in magnitude to one velocity pressure.

Comparative Performance

Fig. 1 compares the performance of a simple single rotation fan having a constant blade angle of 30 degrees with a contra-rotation combination using the original impeller upstream and a similar impeller but of opposite rotation and a blade angle 24 degrees downstream. The impellers in this case were two impeller diameters apart. The characteristics are plotted in terms of performance coefficients K_q and K_s which represent the cfm and fan static pressure in inches w. g. respectively, of a hypothetical 1 ft diameter, 1000 rpm fan. Actual outputs for other diameters and speeds of fans in the same homologous series can be obtained by the application of the fan laws.

While the results plotted in Fig. 1 give some indication of the relative performances that can be obtained in practice, the peak-pressure coefficient and the peak efficiency shown for the contra-rotation fan by no means represent the highest values that can be obtained. The use in the tests of impellers of low hub ratio (under 35%) and with large tip clearance (3/32 inch radial per foot diameter of impeller) is to be noted and, in the light of earlier

experiments on the effect of tip clearance the gain in pressure of the contra-rotation fan would probably be considerably accentuated had the tip clearance been, say 1/16 inch radial per foot diameter. The peak efficiencies can be regarded as typical of the constant chord, constant pitch angle impellers used in the test.

Tests using the same pair of impellers separated by an axial distance of only half a chord showed a slight gain in maximum pressure accompanied by a drop in efficiency and an appreciable increase in noise emission.

Further Developments

With the effective use of the rotational velocity component made by the downstream impeller, a three impeller combination would appear to have possibilities. However, a study of vector diagrams shows that as maximum pressure is approached the final downstream impeller may stall unless the pitch angle is very much less than that of the upstream impeller. Thus, for maximum pressure development, a three impeller combination would have a very small pitch angle on the final downstream impeller as compared to the upstream pair.

Tests of a modified form of upstream impeller using a slotted arrangement similar to those used in aircraft work appeared to iron out the first stall and gave a higher maximum pressure than was obtained from any combination previously tried.

A study of noise emission showed that a contra-rotating fan consisting of one 30 degree and one 24 degree impeller had a noise level of about 76 db while a single 24 degree impeller of increased tip speed to give comparable performance operated at 90 db.

In order to get a true comparison of performance of various classes of fans now available, the use of a corrected relative coefficient is suggested.

The static pressure coefficient, K_s, used earlier, relates the fan static pressure to peripheral speed. It is evident, however, that peripheral speed is not the sole factor influencing the generation of noise. Therefore data which relate pressure development directly to noise emission should give a correct indication of the relative merits of various types of fan.

Corrected Relative Pressure

The corrected relative pressure coefficients given in Table 1 are modifications of optimum static pressure coefficients which account for inherent differences in noise emission for various types of fan. These corrected coefficients compare the static pressure developments on an equal noise basis. A further modification is the adoption of unity ($10 \times K_s$) for the datum which is taken as the value of the corrected relative pressure coefficient for the simplest form of axial-flow fan.

The values given in Table 1 can only be regarded as very approximate and may be modified by further tests taking into account a large number of variables in fan design and the idiosyncrasies of noise transmission.

TABLE 1—CORRECTED RELATIVE PRESSURE COEFFICIENTS OF VARIOUS FANS

Type of Fan	C.R.P. Coeff.
Single Rotation Axial Flow:	
(a) Constant chord, constant pitch angle, small hub ratio	1.0
(b) Varying chord, varying pitch angle, medium to large hub ratio	1.4
(c) As (b) but with either upstream or downstream guide vanes	1.6
Contra-Rotation Axial Flow:	
(d) Otherwise as (a)	2.4
(e) Otherwise as (b)	3.3
(f) As (e) but with very fine tip clearances or use of slotted impellers	3.6
Centrifugal Fans	4.5-6.0

Drives

Contra-rotating fans may be driven by either a single motor or by two motors, one for each impeller. In single motor models, one impeller is driven by the rotor and the other by the stator of the motor which revolves in the opposite direction and is fed through slip rings. This type of fan is manufactured by De Bothezat Division of American Machine & Metals, Inc. Since each impeller revolves at half motor rpm, small high speed motors can be used without excessive blade tip speeds.

The two-motor drive may be more generally adopted in Great Britain. While the two motors double the risk of partial breakdown, they may be regarded as halving the risk of total shut down. For such applications as mine ventilation, the contra-rotating fan can be designed so that the downstream impeller working with upstream idling will cope with the equivalent orifice for which the complete unit was designed. To handle emergency operation involving the driving of the upstream impeller only, special care would have to be taken to ensure that the stall point of the impeller is not reached.

Reversibility

One of the advantages of the axial-flow fan is that it can be run in reverse direction giving a reversed air flow of 60 to 70% of normal. Single rotating fans designed for higher pressure applications do not have this advantage since they ordinarily produce very low output in reverse. In contrast, the percentage reduction in volume when reversing a contra-rotating fan is little greater than is the case with the low pressure non-guide vane single rotating fan.

The simplest method of obtaining a modified output for contra-rotating fans is to drive the downstream impeller while the upstream impeller idles. The output so obtained is 2/3 normal volume and may be 5% in volume and 10% in pressure below that obtainable from a similar impeller without the interference of an idler upstream. For special applications, further control may be obtained by dynamic braking on the upstream impeller.

Applications

There are a number of duties for which the contra-rotating fan is particularly suitable. For marine work, its high pressure development, reversibility, and ability to be concealed in ductwork are important as is also the 2/3 volume control. The same features recommend this type of fan for mine ventilation. High efficiency and simple regulation are especially important in permanent tunnel ventilation.

Effectiveness of Fire Tube Inserts in Boilers and Furnaces

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Spiral metal inserts which act as flame retarders in flue passes of fire tube boilers and furnaces, have demonstrated overall efficiency gains of the order of 5% and consequently are being widely used. This article describes a study of the design of such inserts looking toward obtaining this improved efficiency without the offsetting loss resulting from soot deposits.

WHILE spiral metal inserts, called flame retarders, have been used effectively for many years in horizontal return fire tube boilers, as shown in Fig. 1, they have had the double disadvantage of adding appreciably to frictional resistance of the passages and of forming a tortuous surface for the build-up of soot. With tall industrial chimneys and regular maintenance programs on large boilers, these disadvantages are not serious, but with the growing use of packaged boilers and industrial warm air furnaces, some thought was warranted regarding the possibility of a substitute means of increasing heat transfer efficiency while retaining a low maintenance, low friction, flue passage. The use of multiple units increases the maintenance problem; forced draft sets a premium on flue resistance; and reverse flow of return air against final flue passes tends to increase temperature difference across the flue walls at flue outlets thus increasing the precipitation of soot at that point.

It was reasoned that, since gas flow through fire tubes is normally turbulent, the spiral pathway created by the inserts would, in itself, play a relatively minor part in increasing heat transfer by conduction or convection from the gases to the tube wall. The wiping effect of gas against tube wall would be practically unaffected by the induced secondary whirling of the gas. The remaining factor of radiation, then, must be the major influence affecting overall efficiency; and radiation from the insert surface to the tube wall must be the quantity involved.

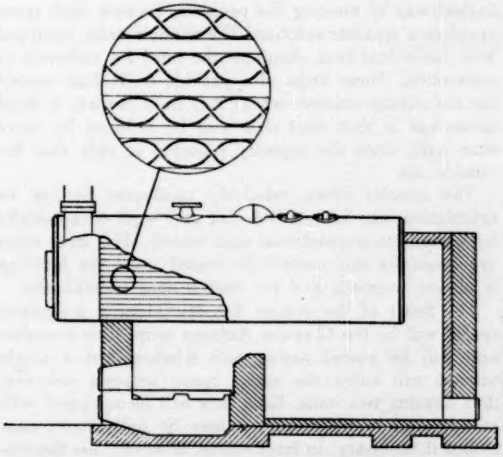


Fig. 1. Horizontal return boiler with spiral inserts in tubes.

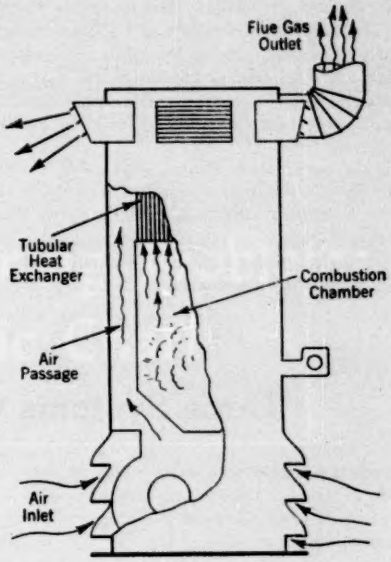


Fig. 2. Cutaway diagram of test furnace.

Experiments were made in direct-fired unit heaters designed with a section of 32 vertical tubular flue passages which act as a second pass for air previously heated by passage around the combustion chamber. This unit is shown in Fig. 2. Tests with and without spiral inserts confirmed previous work with this device and showed an increase of 3.4% in overall efficiency.

A calculation was made to determine the role of radiant heat exchange between the spiral inserts and tube walls. From readings of gas and air temperatures, the mean tube wall temperature was determined as 425F and the mean spiral temperature as 650F. Heat transmitted was then calculated from the equation

$$q = \sigma \, A_{ef} \left[\left(\frac{T_1}{F_A} \right)^4 - \left(\frac{T_2}{F_A} \right)^4 \right]$$

where q = radiant transfer from spiral to air outside tube, Btu per hr

σ = Stefan-Boltzman radiation constant = 0.173 Btu per (hr) (sq ft) (F)

A = area of spiral surface = 20 sq ft
e = emissivity of spiral = .95
f = effective film coefficient, outside tube to air, = .40
T_1 = absolute temperature of spiral = 650 + 460 = 1110R
T_2 = absolute temperature of inside tube wall = 425 + 460 = 885R
F_A = angularity factor, assumed to be 100.

By substitution,

q = 11,850 Btu per hr

Based on the measured rate of burning 2.5 gal per hr of No. 2 fuel oil at 141,000 Btu per gal, the fraction of heat transferred by radiation from the spiral would be 11,850/352,500 = 3.36%. This compares closely with the increase in overall efficiency of 3.4% determined from Bureau of Standards charts by measuring volume, temperature, and CO_2 content of effluent flue gases.

Flat strip, angle iron, and rod shaped inserts, shown in Fig. 3, were then tested and resulted in a similar increase in efficiency of 3.1%.

Flue gas outlet temperatures with spiral inserts were reduced by 125 degrees; and with flat strips by 115 degrees. In both these tests a great deal of care was taken to see that there was no contact between inserts and tube walls. Actually, tests with and without such contact yielded exactly the same results. Rods and angles produced practically the same results as strip inserts, while the strip insert has the advantage of forming a built-in scraper which can simply be turned in the vertical tube to loosen any soot accumulation. Soot then falls down the tube and into the combustion chamber.

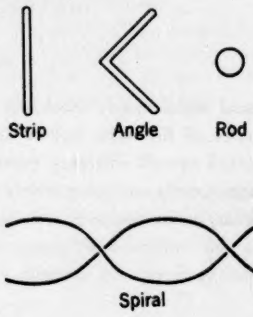


Fig. 3. Various types of fire tube inserts tested.

The effectiveness of flame retarders in boilers would be greater than in warm air furnaces. The film coefficient for boiling liquid in contact with metal is extremely high compared to that for transfer of heat from metal to flowing air. The coefficient for the outside of the fire tube, therefore, is the factor governing the increased effectiveness of flame retarders in fire tube boilers.

Three Systems Cool New York Building

A method of air-conditioning which utilizes the best features of several systems is being installed in New York's new 32-story Chrysler Building East, companion structure to the original 77-story Chrysler Building.

The engineering firm of Guy B. Panero, designers of the Chrysler Building East's air-conditioning system, points out that the newness lies in their combining and applying three well-known air-conditioning procedures to the Grand Central area's newest skyscraper. The design provides a flexible way of treating the concourse and first floor area, thereby increasing the amount of desirable space which may be rented.

The three systems used are all planned to maintain 80F, D.B. and 50% R.H. During the heating season a temperature of 72F will be maintained.

The first system combines heating and cooling and is designed to take care of all perimeter space (approximately 16 ft back from the outside wall) from the second through the 32nd floor. This system will employ window type air-handling units supplied from a central source.

The second system will consist of conventional metal ducts distributing conditioned air to all interior space from the second through the 32nd floor.

The third system covers the rentable space in the concourse and first floor. Outside air duct work and chilled water piping to the fan rooms will be installed, and conventional air handling systems for the various stores and other spaces will be added later.

More than 1400 tons of refrigeration will be required to cool air for the more than 420,000 sq ft of floor area in the building.

For conventional air-conditioning systems, the outside air quantities are based on a minimum of 25% of the total air handled. For interior systems during the intermediate seasons half the air handled will be outside air. The outside air intakes for the future systems on the concourse and first floor have been designed to handle up to 100% outside air during the intermediate seasons.

Dividing the air-conditioning into three parts is a logical way of meeting the problem, because each space requires a separate solution. The window units, equipped with individual fans, eliminate the need for radiators or convectors. These units also provide individual control for the outside rooms—where it is most needed. A third advantage is that duct sizes can be reduced by more than half, since the capacity required is only that for outside air.

The interior areas, relatively unaffected by sun or orientation, can be handled best and most economically by a separate conventional duct system. The store areas are generally not completely rented until the building is almost finished, and are best treated individually.

The heart of the system for conditioning peripheral spaces will be the Chrysler Airtemp units. One complete unit will be placed under each window, but a single cabinet will cover the entire space between columns, thus housing two units. Each unit will be equipped with an automatic valve so that it may be individually controlled if necessary. In large offices, however, one thermostat may control two to four units.

Solving Air Conditioning Problems by Psychrometric Chart

WM. B. FOXHALL
Associate Editor, Heating and Ventilating

Solving Air Conditioning Problems by Psychrometric Chart

Principles involved in use of a psychrometric chart in air conditioning are outlined with reference to a typical chart plotted from standard data. Examples illustrate a wide range of problems in heating, cooling, and humidity control. A set of charts plotted from data compiled by Herbert Herkimer for finding apparatus dew points, is included.

WM. B. FOXHALL

Associate Editor, Heating and Ventilating

A PSYCHROMETRIC chart is a graph of the properties of moist air at various conditions of temperature and humidity. Many such charts are in use, such as the Trane, Carrier, General Electric, Goff and Gratch, Mackey, and others. The chart shown in Fig. 1 was plotted from data supplied by the U. S. Weather Bureau and other sources. It is typical of most such charts and is intended to serve as an illustration of the utility of the graphical method. For actual engineering practice, the same scale range over a larger area would be preferred.

Properties of Air

The variable properties of moist air pictured in Fig. 1 at a single pressure (standard atmospheric) are as follows:

Dry bulb temperature, degrees F, the major vertical coordinates with scale of degrees at the bottom of the chart. Dry bulb is the temperature read on an ordinary room thermometer.

Weight of water vapor in one pound of dry air, grains, the major horizontal coordinates with scale of grains per pound of dry air at the right. A grain is 1/7000 of a pound. Quantities of air and moisture in weight units are used to simplify the presentation. The weight of vapor is, of course, the weight of water which has been evaporated into the air. The vapor is actually steam which occupies its own fraction of space and exerts its own pressure in proportion. Thus, in ordinary air, it is very low pressure steam and evaporates into the air at a temperature corresponding to the boiling point of water at that very low pressure.

Pressure of water vapor, inches of mercury, shown in the scale at the left, is the absolute pressure of the steam, and *Dew point temperatures,* shown in the scale on the upper curved line, are the corresponding boiling points of water at those low pressures. If a single vapor coordinate in Fig. 1, say 96 grains, is followed from the right scale toward the left and across the decreasing dry bulb temperature coordinates, the steam will cool until it reaches the boiling point corresponding to its own (very low) pressure at 66F. The steam will then begin to condense back into water and fog will appear to the left of 66F at the 96 grain level. This establishes the point where the 66F dry bulb and 96 grains moisture coordinates meet at a condition called saturation because the amount of water in air at 66F cannot be increased beyond 96 grains without condensation. Also, if there are 96 grains of moisture per pound of dry air at any temperature, no matter how high, that air will have to be cooled to 66F before condensation takes place. So the dew point temperature coordinates are also horizontal in Fig. 1. Each dry bulb temperature and weight of vapor combination has a corresponding saturation point which establishes the 100% relative humidity or saturation curve.

Percent relative humidity curves show the number of grains of moisture actually in the air as a fraction of the total amount possible at the various dry bulb and vapor weight combinations.

Total heat, Btu per pound of dry air, is shown in Fig. 1 by a diagonal system of coordinates with its scale on the diagonal line separate from the body of the chart and above the saturation curve. A certain amount of heat (.24 Btu) is required to raise the temperature of a pound of air one degree. This is called sensible heat because its effect can be sensed by a dry bulb thermometer. Another definite amount of heat (1 Btu) is required to raise the temperature of one pound of water one degree. This is also sensible heat in that it affects a thermometer reading, but is called heat of the liquid. The third component of total heat in a given sample of moist air is the heat required to convert the water at the dew point to steam at the same temperature. Since no temperature change is involved, this component is called the latent heat of vaporization. Total heat on the chart is the sum of the heat required to warm a pound of air from OF to dry bulb, plus the heat to warm the water in a pound of air from 32F to dew point, plus the latent heat required to vaporize that much water at dew point. Total heat is also called enthalpy, and will be discussed at some length.

Wet bulb temperatures are shown on diagonal coordinates coinciding with the total heat coordinates but with their scale shown on the saturation curve. Wet bulb is the temperature assumed by an evaporating film of water in air at constant dry bulb and dew point. It is discussed more fully under a later subhead.

Any two known properties of air determine a point on the chart called a state point from which all other properties can be read. For example, to find the wet bulb of air at 78F D.B. and 50% R.H., enter the chart at 78F on the bottom scale, as in Fig. 2, proceed up to the 50% curve and read diagonally upward to 64.8F on the wet bulb scale as shown in Fig. 2. Construction of the chart and coordinates for a single state point are shown in Fig. 3.

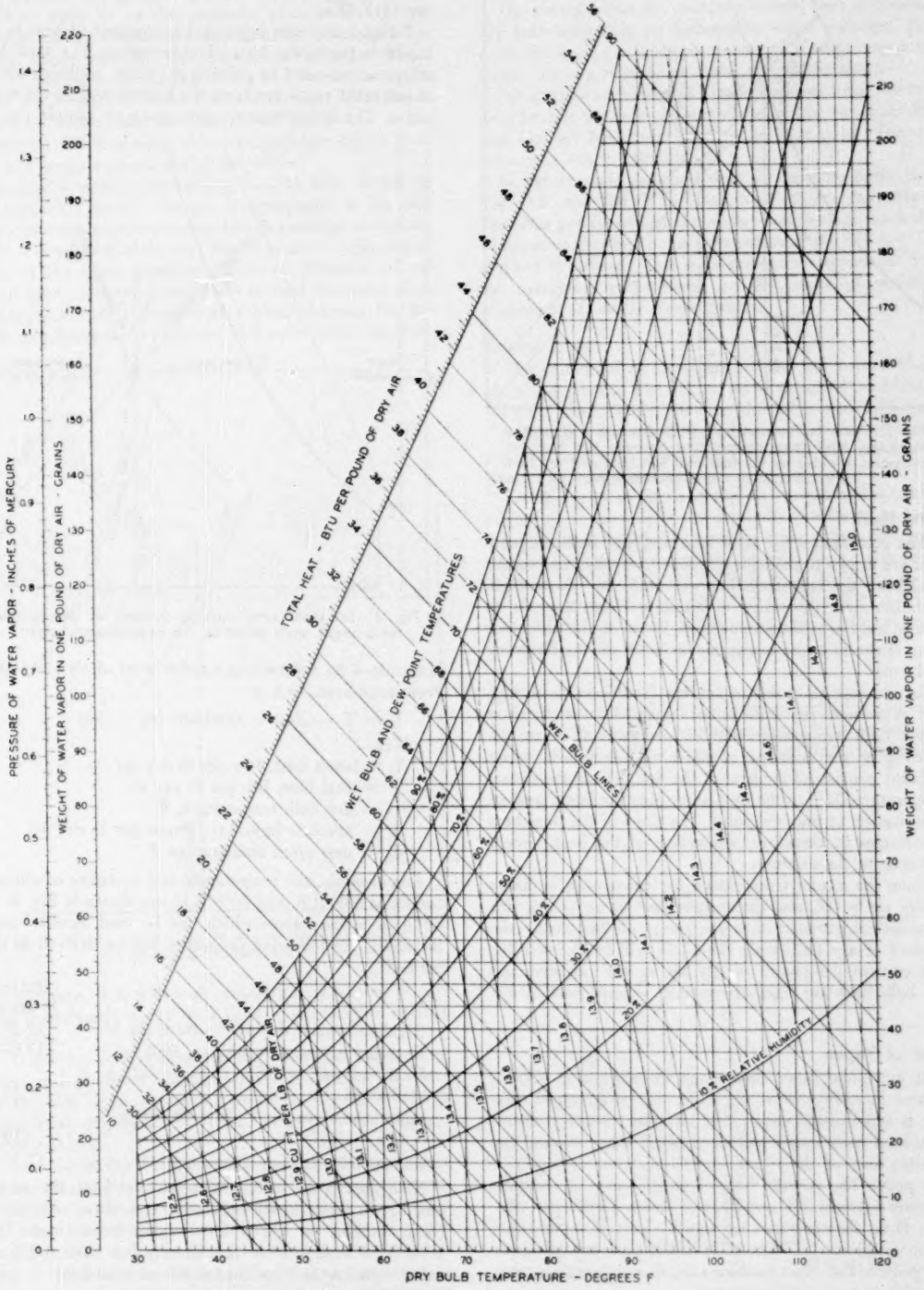

PRESSURE OF WATER VAPOR - INCHES OF MERCURY
WEIGHT OF WATER VAPOR IN ONE POUND OF DRY AIR - GRAINS
TOTAL HEAT - BTU PER POUND OF DRY AIR
WET BULB AND DEW POINT TEMPERATURES
WET BULB LINES
RELATIVE HUMIDITY
CUBIC FEET PER LB OF DRY AIR
WEIGHT OF WATER VAPOR IN ONE POUND OF DRY AIR - GRAINS
DRY BULB TEMPERATURE - DEGREES F

Fig. 1. Psychrometric properties of air at 29.92 inches of mercury absolute pressure.

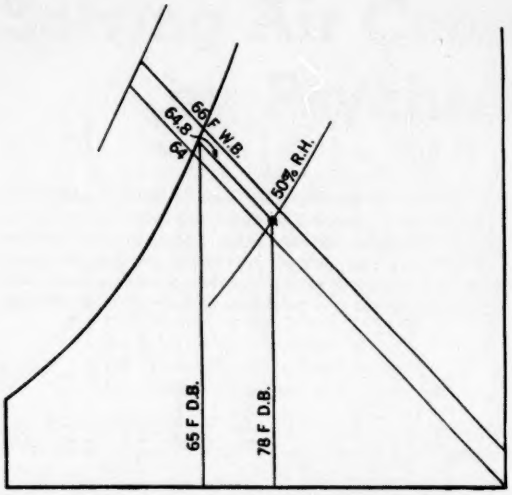


Fig. 2. How to find wet bulb from dry bulb and relative humidity. Note that interpolation between wet bulb coordinates is aided by the fact that wet bulb and dry bulb are identical at the saturation curve.

Total Heat

The coordinates for total heat and wet bulb temperature are drawn to coincide in slope. Actually, at constant total heat, the corresponding wet bulb may show slight variation over the range of humidity from dry air to saturation. For practical purposes, however, the difference is so slight as to be negligible in most air conditioning problems.

An increase in moisture content from zero to saturation at constant dry bulb is accompanied by an increase in wet bulb temperature and in total heat at a rate depending on the enthalpy of the moisture added. Vapor enthalpy consists of the heat of the liquid from the datum temperature, 32F, to the dew point plus the latent heat of vaporization at the dew point. The slope of the total heat coordinates is, therefore, a function of the heat content of vapor in the mixture.

Since the datum temperature for calculating enthalpy of dry air is OF, and the specific heat of air is .24 (for all practical purposes over the range of this chart) the product of dry bulb scale times .24 will be the sensible heat content per pound of dry air in any mixture, and dry bulb lines are lines of constant sensible heat of dry air.

Heat of Vapor

At any point other than along the saturation (100% relative humidity) line, the vapor in an air-vapor mixture is superheated steam. For absolute accuracy, therefore, total heat would include a small value allowed for sensible heat of the vapor in cooling from dry bulb to dew point. The specific heat of water vapor at constant pressure between 32F and 212F is about .45 Btu per (lb) (F). Thus, the allowance for sensible heat of superheated vapor would be .45/7000=.00006 Btu per (gr) (F above dew point). For most problems in air conditioning practice, this is a negligible amount.

Another component of total heat is the heat required to warm the liquid from the datum temperature, 32F, to the dew point. For all practical purposes, this can be figured at 1 Btu per (lb) (F) or 1/7000=.000143 Btu per (gr) (F).

Perhaps the most important component of heat in the vapor is the latent heat of evaporation. For total heat computations used in plotting the chart, enthalpy values of saturated vapor are from the Keenan and Keyes steam tables. The latent heat in any air-vapor sample can be

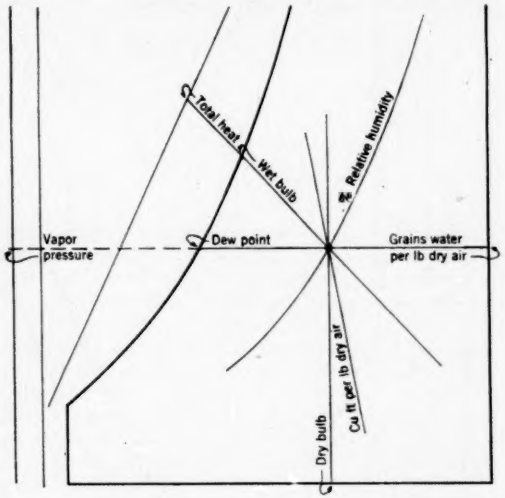


Fig. 3. Skeleton chart showing systems of coordinates for a single state point on the psychrometric chart.

determined by subtracting sensible heat of air and liquid from total heat. That is

$$L = T - .24t - .000143h\ (d_p - 32)$$

where

L = latent heat, Btu per lb dry air
T = total heat, Btu per lb dry air
t = dry bulb temperature, F
h = absolute humidity, grains per lb dry air
d_p = dew point temperature, F

For example, the temperature and moisture conditions for air at 80F D.B. and 50% R.H. are shown in Fig. 4. In addition to the values which can be read directly from the chart, the following properties can be derived as described:

	Btu per lb dry air
Sensible heat of dry air = 80 x .24 =	19.20
Enthalpy of vapor = 31.2 — 19.2 =	12.00
Heat of liquid = 76 x (59.7 — 32) x .000143 =	.30
Superheat of vapor = 76 x .00006 x (80 — 59.7) =	.10
Latent Heat of Evaporation = 12.00 — .30 =	11.70

Note that in the computation of total heat, the superheat of the vapor is not included and so is not subtracted from enthalpy of vapor in deriving latent heat. The amount of superheat in this case is less than 0.9% of vapor enthalpy and less than 0.4% of total heat.

Wet Bulb Temperature

Wet bulb temperature is the lowest temperature to

which a film of water can be brought by free evaporation into air at constant dry bulb and dew point.

When water is in the presence of unsaturated air, there is always a boundary condition in which two opposing influences exist. (1) There is an exchange of heat by conduction to the cooler of the two media; and (2) there is a transfer of vapor to the medium of lower vapor pressure. Unsaturated air, by definition, has a vapor pressure lower than water at any temperature higher than the dew point temperature of the air.

A film of water, approaching the dry bulb of the air by conducted heat exchange, is evaporated at the dew point saturation pressure at a rate depending on the degree of saturation of the air; that is to say, on the magnitude of the vapor pressure difference. Removal of the latent heat of evaporation tends to cool the water film, and equilibrium is reached at a point between the dry bulb and dew point of the air. This point is the wet bulb

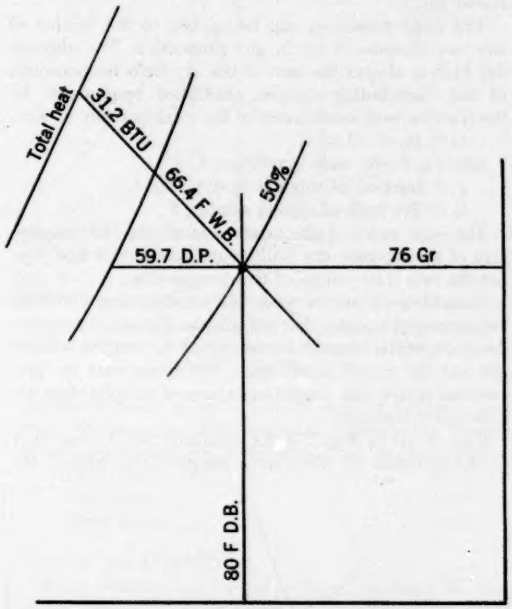


Fig. 4. Direct readings of heat and moisture properties at a single state point.

temperature. It is a directly measurable property of air, and is extremely useful as a limit in evaporative cooling problems.

As the dry bulb approaches the dew point, vapor pressures of both water film and air approach that of steam at the dew point saturation pressure. Hence, at 100% saturation, dry bulb, dew point, and wet bulb temperatures coincide.

At constant dry bulb, any increase in moisture content of air results in an increase in total heat. Since the sensible heat of the air remains constant, such an increase in total heat must be entirely an increase in vapor enthalpy. The influence of conduction at a water interface is stable at constant dry bulb, because conduction is a function of temperature. Therefore, the influence of evaporation is affected exclusively and directly by an increase in moisture content; the wet bulb is thus a direct function of total heat; hence total heat and wet bulb lines may coincide in slope.

The notation that any increase in total heat at constant dry bulb is entirely an increase in vapor enthalpy, provides the basis for a simple means of reading vapor enthalpy for any state point directly from the chart.

For example, as shown in Fig. 5, the procedure is to read total heat at the zero moisture level of the dry bulb line and subtract from total heat at the state point. The difference is vapor enthalpy.

In the example shown in Fig. 5, the state point is at 75F D.B. and 58F W.B. Total heat at zero moisture is 18.0 Btu per lb and at the state point is 25.0. Enthalpy of vapor at the state point is therefore 25.0 — 18.0 = 7.0 Btu per lb dry air. This is in reasonable agreement with the calculated value based on 45 grains of moisture evaporated at 45.2F (dew point).

Volume Lines

The volume of an air-vapor mixture per pound of dry air is indicated in Fig. 1 by a set of diagonal coordinates with the scale shown between the 20% and 30% relative humidity curves. In addition to the volume of mixture for any state point, the volume of dry air and of steam can be derived.

For example, as shown in Fig. 6, by reading the volume of dry air at the base of the dry bulb coordinate and subtracting from total volume at the state point, volume of steam is obtained. According to Fig. 6, the volume of mixture at 70F D.B. and 50% R.H. is 13.52 cu. ft. per lb. dry air and the volume of dry air at 70F is 13.35. The volume of vapor at this state point, therefore, is .17 cu ft per lb dry air.

Use of the Chart

A principal use of the psychrometric chart is to visualize over-all changes in properties of air between one state point and another. Changes in dry bulb temperature

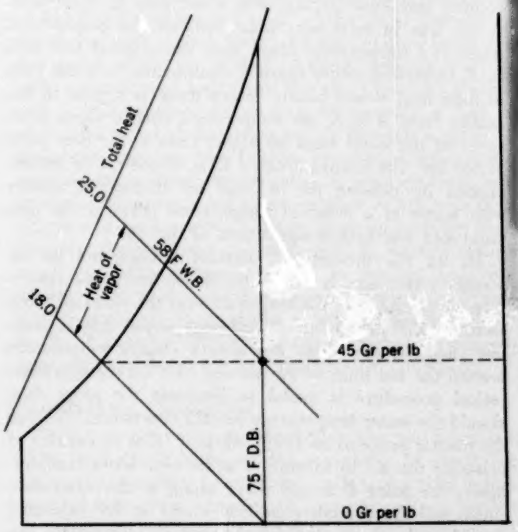


Fig. 5. Direct reading of vapor enthalpy (heat of vapor) as the difference between total heats of sample air and dry air at the same dry bulb.

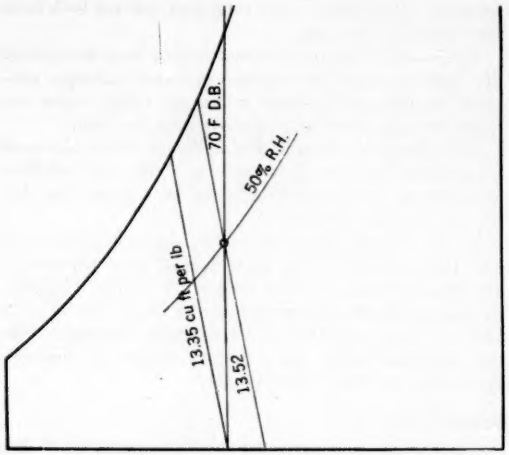


Fig. 6. Direct reading of vapor volume as the difference between volumes of actual state and of dry air at the same dry bulb temperature.

without an accompanying change in moisture content (sensible heating or cooling) simply follow along the horizontal coordinates at the original moisture level. When a change in moisture content accompanies a temperature change, the intervening process between two state points becomes more complex, and the line joining the two points is an indication of the means by which the change can be brought about.

Cooling and Humidifying

For example, in Fig. 7, the change from point *A* (90F D.B., 20% R.H.) to *B* (70F D.B., 50% R.H.) represents a cooling and humidifying process accompanied by a net loss in total heat (28.3 — 25.4 = 2.9 Btu loss per lb. dry air) while the line *A—D* represents sensible cooling and humidifying with a net gain in total heat. A net loss in total heat must indicate the presence of water at a temperature lower than the original wet bulb at *A*. Otherwise either thermal equilibrium or a net gain in total heat would obtain. Since there is a gain in humidity from *A* to *B*, the temperature (hence vapor pressure) of the water must be higher than at the dew point of the air. The change from *A* to *B*, therefore, is accomplished by passing the original air through a washer with water at a constant temperature between the dew point and wet bulb temperatures of the air.

To fix the theoretical, constant temperature of the washer water, simply extend the *A—B* line to the saturation curve and read the temperature at the point of intersection (55F in this case). Although impossible in practice (because the water will always change temperature toward the wet bulb of the air and vice versa) this theoretical procedure is useful to illustrate the point that, should the water temperature remain constant at 55F and the washer prove to be 100% efficient (that is, capable of bringing the air to saturation at its own water temperature), the point *B* would move along to the saturation curve, and the ultimate condition would be 55F saturated air. Thus the distance *A—B*, in relation to the total distance from *A* to saturation, is the efficiency of the washer.

In actual practice, the washer water will warm (or cool) toward the wet bulb of the air supplied to it. The condition line, then, would follow some curve similar to the dashed curve in Fig. 7.

Another means of changing air from condition *A* to *B* would be by mixing the original air with a specified amount of cooler air.

For example, if one part of air at condition *A* were mixed with three parts of cooler air, the dry bulb of the cooler air would be determined by the formula

$$t_c = \frac{70 - (.25 \times 90)}{.75} = 63.3$$

where t_c is the dry bulb temperature of the cooler air.

Note that the intersection of this dry bulb line with the extension of the *A—B* line fixes the state point of the cooler air at point *C* in Fig. 7. Also, the length of the line *B—C* is equal to one-third of the distance *A—B*, representing the one part of warmer air to three parts of cooler air.

The same reasoning can be applied to the mixing of any two samples of air in any proportion. The ultimate dry bulb is always the sum of the dry bulb temperatures of the contributing samples multiplied respectively by the fraction each contributes to the total quantity of air.

$t_u = xt_1 + (1\text{-}x)\ t_2$

where t_u = dry bulb of mixture, F

x = fraction of mixture at dry bulb t_1

t_2 = dry bulb of second sample, F

The state point of the mixture is always the intersection of the ultimate dry bulb coordinate with a line joining the two state points of the components.

Quantities of air in most air conditioning problems are expressed in cubic feet per minute. For strict accuracy these quantities should be converted to weights of dry air, but for practical examples depending only on proportions mixed, the quantities expressed in cubic feet are sufficiently accurate.

Line *A—D* in Fig. 7 is the condition line for air at *A* in the presence of water at a temperature between the

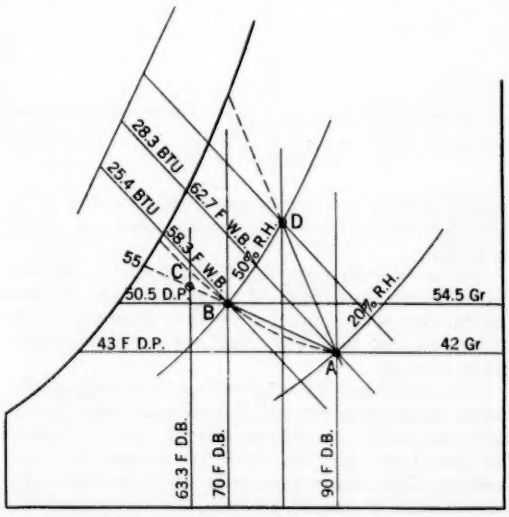


Fig. 7. Action of air washer and mixture of air streams in cooling and humidifying with water above the dew point of air.

original wet bulb and dry bulb temperatures of the sample. It is of interest in showing a decrease in dry bulb accompanied by an increase in total heat.

If water is continuously recirculated in any air washer without being heated or cooled by any means other than action of the air, the water will assume the wet bulb temperature of the air and changes in state point of the air will follow directly along the wet bulb line of the original sample. The distance moved as a fraction of the total distance from the original point to saturation, is, again, the efficiency of the washer.

Actually, the effect is that of a mixture of two portions of the stream of air. One portion contacts the water and becomes saturated. The other portion by-passes the water and is unaffected. The degree of contact is affected by the

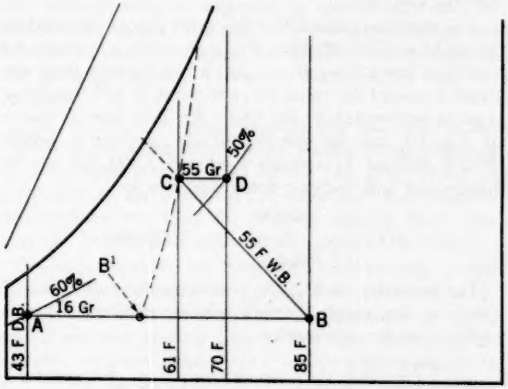


Fig. 8. Heating with coils, humidifying with washer. Washer water may be either unheated (solid line) or heated (broken line).

number of banks of spray nozzles and the fineness (pressure) of the spray. Efficiencies of recirculating washers of average commercial construction are approximately:

Single bank	65%
Two banks	80%
Three banks	90%

Heating and Humidifying

Many commercial central systems combine the principles outlined in an arrangement of coils and air washer to heat and humidify air.

For example, if outside air at 34F and 60% R.H. (point *A* in Fig. 8) is to be delivered to a room at 70F and 50% R.H. (point *D* in Fig. 8), it can be introduced through a heating coil which will heat it to 85F without adding moisture (line *A*—*B*). The heated air then goes through an 80% efficient recirculating washer in which the water is in thermal equilibrium at the wet bulb temperature of the air (55F). Air cools and absorbs moisture at constant total heat and emerges at point *C*, 80% of the distance from *B* to the saturation curve. Air is now at 61F D.B. and is reheated to 70F in a second coil to point *D*.

It is apparent in Fig. 8 that an increase in the exit temperature at the first coil will raise the equilibrium temperature of the circulating water and the moisture level of the air emerging from the washer.

An alternate method is to decrease the exit temperature (and load) at the first coil to a point such as B^1 in Fig. 8. The washer water is then heated to some temperature above 61F and heats and humidifies the air along a condition line such as B^1—C. The reheating coil functions as before.

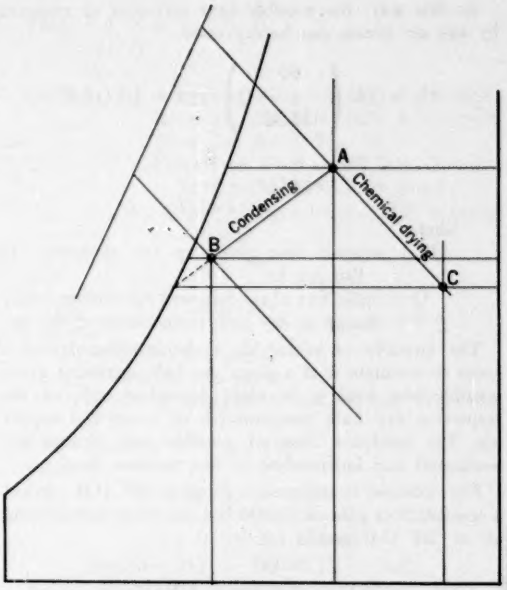


Fig. 9. Dehumidifying air by (1) cooling in contact with surface below dew point, line A-B, and (2) absorbtion of moisture by chemicals at constant total heat, line A-C.

Dehumidifying

Moisture can be removed from air by two processes; (1) by cooling below its dewpoint so that condensation occurs, and (2) by absorption through means of hygroscopic chemicals. The first can be accomplished by passing the air through a cooling coil the surface temperature of which is below the dew point of the air or through an air washer with chilled water at a temperature below the dew point of the air. Either of these methods removes both moisture and heat from the air. Chemical absorption is accomplished by passing air through a bed of absorbtive material, like silica gel or through a spray of absorbtive solution, like lithium bromide. Chemical absorbtion takes place, theoretically, at constant total heat so that it is accompanied by an increase in dry bulb temperature of the air as the moisture gives up its latent heat. The two processes are shown in Fig. 9, where the line *A*—*B* represents dehumidification by cooling and condensing and the line *A*—*C* represents drying by hygroscopic chemicals. It should be noted that the line *A*—*B* in Fig. 9 does not show the progressive changes through the cooling medium, but only the terminal conditions.

Psychrometric Calculations

Owing to the necessity of plotting the psychrometric chart on a weight basis and the convention of specifying air supply quantities in cubic feet (cfm), practical design practice is to avoid complicated conversions from weight to volume at various state points by assuming all air supply to be at standard specific volume of 13.34 cu ft per lb and standard specific heat of .24 Btu per (lb) (F).

In this way, the sensible heat delivered or removed by any air stream can be expressed

$$H_s = .24 \left(\frac{60}{13.34} Q \right) \triangle T = 1.1\, Q \triangle T$$

$$\text{and } Q = \frac{H_s}{1.1 \triangle T}$$

where

H_s = sensible heat given up (or absorbed) in Btu per hr

Q = cubic feet of air delivered per minute (cfm)

$\triangle T$ = change in dry bulb temperature of the air.

The quantity of cooled air to be introduced into a room to maintain it at a given dry bulb against a given sensible heat load is therefore dependent only on the respective dry bulb temperatures of room and supply air. The condition lines of sensible heat change are horizontal and independent of the moisture level.

For example, to maintain a room at 80F D.B. against a sensible heat gain of 20,000 Btu per hr by introducing air at 58F D.B. would require

$$Q = \frac{20{,}000}{1.1\ (80\text{-}58)} = 826 \text{ cfm}$$

If, now, the moisture condition in the room is fixed at 50% R.H. (point *A*, Fig. 10), it is apparent in Fig. 10 that even saturated air at 58F can not be introduced to handle the sensible heat load without dehumidifying the space to about 47% along the line *B—C—unless there is an additional latent load of humidity gain in the room.*

If a latent load is imposed on the space and is exactly offset by 826 cfm of saturated air introduced at 58F, the slope of the condition line is no longer horizontal but follows the dashed line *A—B* in Fig. 10 from 58 at saturation to the room state point. Calculation shows the latent heat added by supply air to be about 15% of the total heat added. This calculation is based on the geometry, measured in heat units, a gain of four (76—72) grains of moisture per pound dry air over the length of the condition line intercepting a total heat gain of about 6 Btu per pound dry air.

The slope of the dashed line in terms of sensible and total heat is, therefore, about 1 — .15 = .85. The slope is thus characteristic of the ratio of sensible to total heat load on the space. Any space with the same sensible heat ratio would have its own state point and that of its compensating supply air on a condition line of identical slope.

In this case, the introduction of saturated air presupposes a 100% efficient cooling apparatus at the dew point 58F. The slope of the condition line characteristic of the sensible heat ratio intersects the saturation curve at the theoretically perfect *apparatus dew point.* This is the temperature on the saturated curve at which the smallest possible quantity of supply air (that is, saturated air on the required condition line) will handle the total load on the space. The position of the intersection (apparatus dew point) on the saturation curve is, of course, fixed by room air conditions and the slope of the condition line characteristic of the sensible heat ratio of the load.

Since all of the conditions along the line *A—B* from the room air state point to saturation will handle the characteristic load on the space, in accordance with the theory of air mixtures previously discussed, apparatus of any practical efficiency can be used to supply air having any state point along *A—B* with compensating adjustment of the amount of supply air to allow for the decrease in temperature difference. The by-pass factor of the apparatus (one minus the efficiency) thus poses a simple problem in air mixture such as has been discussed. That is, the efficiency point will lie on the condition line a proportionate distance to the right of the saturation curve and a compensating increase in supply air quantity will be made based on the smaller value of $\triangle T$ thus obtaining in the denominator of the formula $Q = H_s / 1.1 \triangle T$.

For example, assume that the apparatus in the previous example is 67% efficient. The state point of supply air will then move 1 — .67 = .33 of the distance from saturation toward the room air state point. It will then be at a point intercepted by the 65.3F dry bulb line as shown in Fig. 10, and the quantity of air required to handle 20,000 Btu per hr sensible load and 3,500 Btu per hr latent load will increase from 826 cfm to

$$Q = \frac{20{,}000}{1.1\ (80 = 65.3)} = 1{,}250 \text{ cfm}$$

The geometry of Fig. 10 points up the fact that $\triangle T$ (that is, the range through which conditioned air is cooled) can be expressed as

$$\triangle T = \left[\left(\begin{matrix} \text{Space} \\ \text{D.B.} \end{matrix} \right) - \left(\begin{matrix} \text{Apparatus} \\ \text{Dew Point} \end{matrix} \right) \right] \times \left(\begin{matrix} \text{Apparatus} \\ \text{Efficiency} \end{matrix} \right)$$

This quantity can be substituted in the basic formula for supply air quantity to give

$$Q = \frac{H_s}{1.1\ (t_1 — A_{dp})\ e}$$

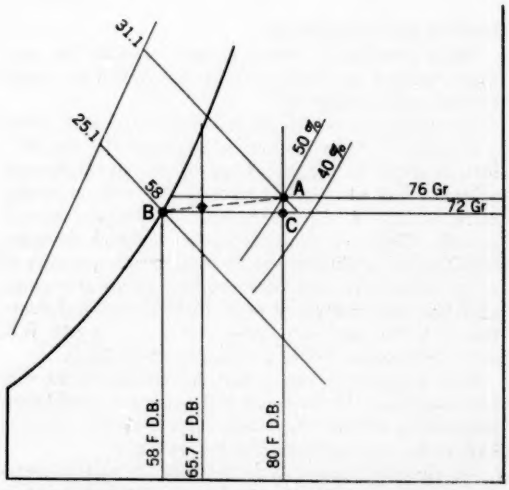


Fig. 10. Geometry of sensible heat ratio, expressed in heat units as B-C/A-B.

where

t_1 = space dry bulb, F

A_{dp} = apparatus dew point

e = efficiency

Apparatus Dew Point

As has been pointed out, the apparatus dew point is the temperature of saturated supply air which will maintain specified conditions of temperature and humidity in a space against given latent and sensible load conditions. There are several methods of determining the apparatus dew point for a given space condition and load. Most methods are based on the existence of a characteristic slope of condition line for each sensible-to-total heat ratio. Protractor diagrams or special rules may be provided by means of which a line of proper slope can be drawn through the space condition to be maintained. The geometric method previously demonstrated can also be used.

The limitation of such methods lies not only in the possibility of error inherent in geometric construction to close tolerances but also in the fact that, owing to differences in the latent heat of vaporization at different temperatures, the lines for a given sensible heat ratio may not be exactly parallel at all points of the chart.

Herbert Herkimer has taken this into account in calculating the apparatus dew points from thermodynamic data for literally thousands of combinations of space conditions and sensible heat ratios. The results of his calculations have been plotted on the charts shown in Fig. 11, 12, 13, 14, and 15. The usefulness of these charts in combination with the psychrometric chart will be shown in the examples which follow.

Examples

(1) Given: the space condition of 80F D.B., 50% R.H. to be maintained against a sensible heat load of 20,000 Btu per hr and a latent load of 7,000 Btu per hr. Supply air is to be delivered at 58F D.B.

Find: (a) wet bulb and dew point of supply air
(b) quantity of supply air
(c) efficiency of required coil or washer

Solution: (a) The sensible heat ratio, $S_R = 20{,}000/27{,}000 = .74$. Reference to the apparatus dew point chart for 50% R.H. (Fig. 13) shows a value of 55.5 for the problem conditions. The condition line is accordingly drawn as shown in Fig. 16. The intersection point of the condition line and 58F D.B. coordinate establishes the condition of supply air to be 56.7F W.B., 56F D.P.

(b) $$Q = \frac{20{,}000}{1.1\ (80-58)} = 826 \text{ cfm}$$

(c) $\Delta T = (t_1 - A_{dp})\ e$, so, $(80-58) = (80-55.5)\ e$

$$e = \frac{22}{24.5} = 90\%$$

Note also that by direct measurement on Fig. 10

$$\frac{\text{length AD}}{\text{length AC}} = .9$$

(2) Given: Same conditions as in previous example except that sensible heat ratio is 60%.

Find: (a) W.B. and D. P.
(b) Q
(c) e

Solution: (a) According to Fig. 13, A_{dp} (at S_R=60%; Room air, 80F D.B., 50% R.H.) =42F
Draw line *A—E*, Fig. 16
Point *F* on *A—E* at 58F D.B. shows:
W.B. = 53.7F; D.P. = 50.6F

(b) Q (not changed because D.B. is same) = 826 cfm

(c) $$e = \frac{(80-58)}{(80-42)} = 58\%$$

(3) Given:

H_s = 16,500 Btu per sh

H_L = 14,700 Btu per hr

1000 cfm is to maintain space at 85F D.B., 69F W.B.

Find: Required W.B. and D.B.

Solution:

$$\Delta T = \frac{H_s}{1.1\ Q} = \frac{16{,}500}{1.1 \times 1000} = 15$$

Required D.B. = 85 — 15 = 70F

Read on Fig. 1: RH. at 85F D.B., 69F W.B. = 45%

Read on apparatus dew point charts:

A_{dp} at 40%, 85F = 53.5

A_{dp} at 50%, 85F = 62.0

By interpolation, A_{dp} at 45%, 85F = 57.7

Draw condition line *A—B* as in Fig. 17. Intersection of condition line with 70F D.B. coordinate shows supply at 62.8F W.B.

(4) Given: Room condition 80F D.B., 50% R.H.

H_s = 75,000 Btu per hr

H_L = 25,000 Btu per hr

Air leaves conditioning equipment at 90% R.H.

Find: Condition and volume of air supply

Solution: Plot point *A*, Fig. 18, at room condition on psychrometric chart.

$$S_R = \frac{75{,}000}{100{,}000} = 75\%$$

From 50% R.H. apparatus dew point chart, Fig. 13, at 80F, 75%,

A_{dp} = 55.8

Draw condition line *A—B*

Locate point *C* on condition line at 90% R.H.

Required condition of supply air is read at *C*:

D.B. = 59.1F

W.B. = 57.5F

$$Q = \frac{H_s}{1.1\ T} = \frac{75{,}000}{1.1\ (80-59)} = 3250 \text{ cfm}$$

(5) Given: Room condition, 80F D.B., 50% R.H.

H_s = 40,000 Btu per hr

H_L = 10,000 Btu per hr

Total volume to be circulated; 3,000 cfm

Find:

(a) condition of chilled-air leaving coils if at 90% R.H.
(b) volume of air to be cooled and dehumidified
(c) volume of recirculated air to be by-passed
(d) condition of mixture of chilled and by-passed air delivered to room

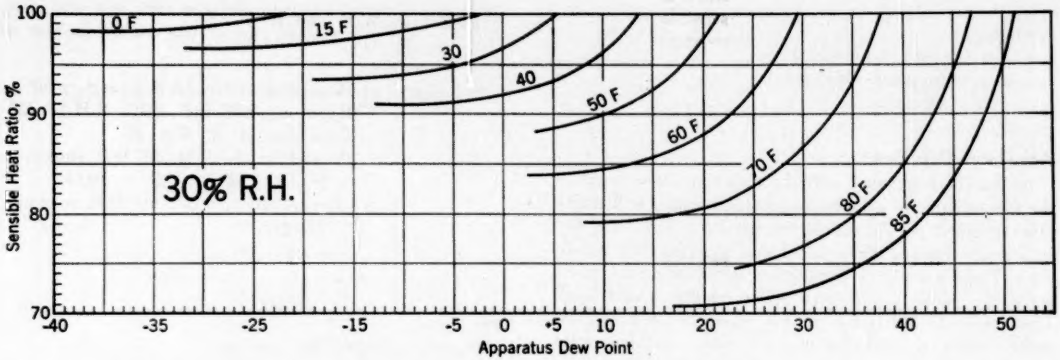


Fig. 11. Chart for finding apparatus dew point to maintain room air at 30% R. H. and various dry bulb temperatures (marked on curves) with loads at various sensible heat ratios.

Solution:

(a) Plot point *A*, Fig. 19, at room condition on psychrometric chart.

$$S_R = \frac{40{,}000}{50{,}000} = 80\%$$

From 50% R.H. apparatus dew point chart, Fig. 13, at 80%, 80F, $A_{dp} = 57.5$

Draw condition line *A—B* and find point *C* on this line at 90% R.H. This fixes the condition of air leaving coils at 60.5F D.B., 58.5F W.B.

(b) $$Q = \frac{40{,}000}{1.1\ (80 - 60.5)} = 2{,}050 \text{ cfm of chilled air}$$

(c) Volume of return air by-passed is

$$3{,}000 - 2{,}050 = 950 \text{ cfm}$$

(d) Since a mixture of two air streams has a state point on a line joining the two conditions as previously described in connection with Fig. 7, the condition of the mixture of chilled and return air in this problem will be fixed by intersection of its dry bulb coordinate with the line *A—C*.

$$\Delta T = \frac{H_s}{1.1\ Q} = \frac{40{,}000}{1.1 \times 3{,}000} = 12.1$$

Hence, temperature of mixture is 80 — 12 = 68F D.B., and its condition at point *D*, Fig. 19, is 61.8F W.B.

Note that the same principles apply when it is desired to fix the temperature of cooled air supplied to a room.

(6) Given: Room condition, 80F D.B., 67F W.B.

$H_s = 50{,}000$ Btu per hr

$H_L = 17{,}500$ Btu per hr

Outdoor air condition, 95F D.B., 78F W.B. Specified circulation, 3,000 cfm, of which 25% is outside air

Chilled air leaves coils at 90% R.H.

Find:

(a) W.B. and D.B. of air supplied to room.

(b) W.B. and D.B. of return and outside air mixture ahead of cooling coils

(c) required conditions of chilled air leaving coils

(d) quantity of air to be chilled

(e) quantity of air to be by-passed

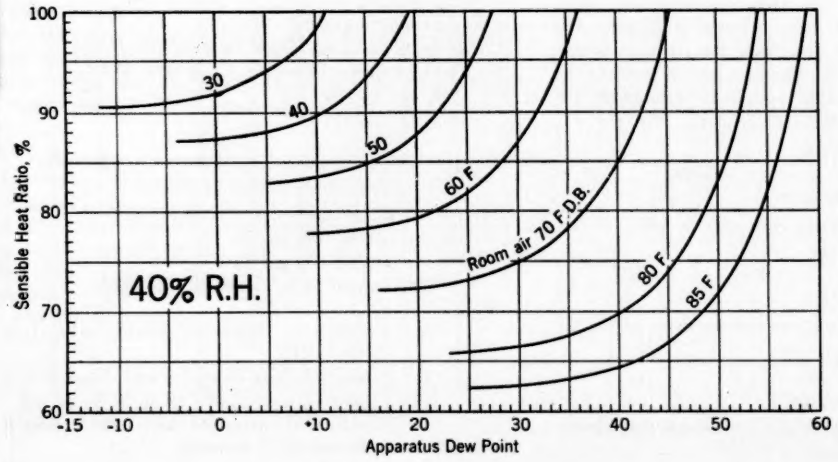
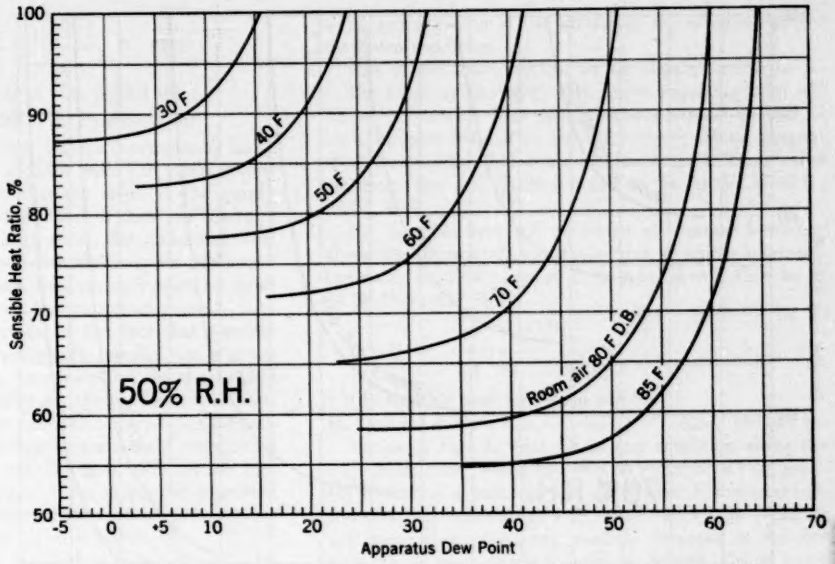


Fig. 12. Chart for finding apparatus dew point to maintain room air at 40% R. H. and various dry bulb temperatures (marked on curves) with loads at various sensible heat ratios.

Fig. 13. Chart for finding apparatus dew point to maintain air at 50% R.H. and various dry bulb temperatures (marked on curves) with loads at various sensible heat ratios.



Solution:

(a) Plot room condition point *A*, Fig. 20, on psychrometric chart.

$$S_R = \frac{50{,}000}{67{,}500} = 74\%$$

R.H. in room = 52.5% (read from psychrometric chart at *A*)

A_{dp} for 50% R.H., 80F D.B., 74% S_R = 55.5 (Read from apparatus dew point chart for nearest R.H., Fig. 13)

Draw slope line A^1—B^1 for nearest condition, from 50% R.H., 80F D.B. through 55.5F on saturation curve. Then draw parallel line through point *A* to find A_{dp} (for 52.5%, 80F D.B., 74% S_R) = 56.5

Since 3,000 cfm will be supplied to room,

$$\Delta T = \frac{50{,}000}{1.1\ (3{,}000)} = 15F$$

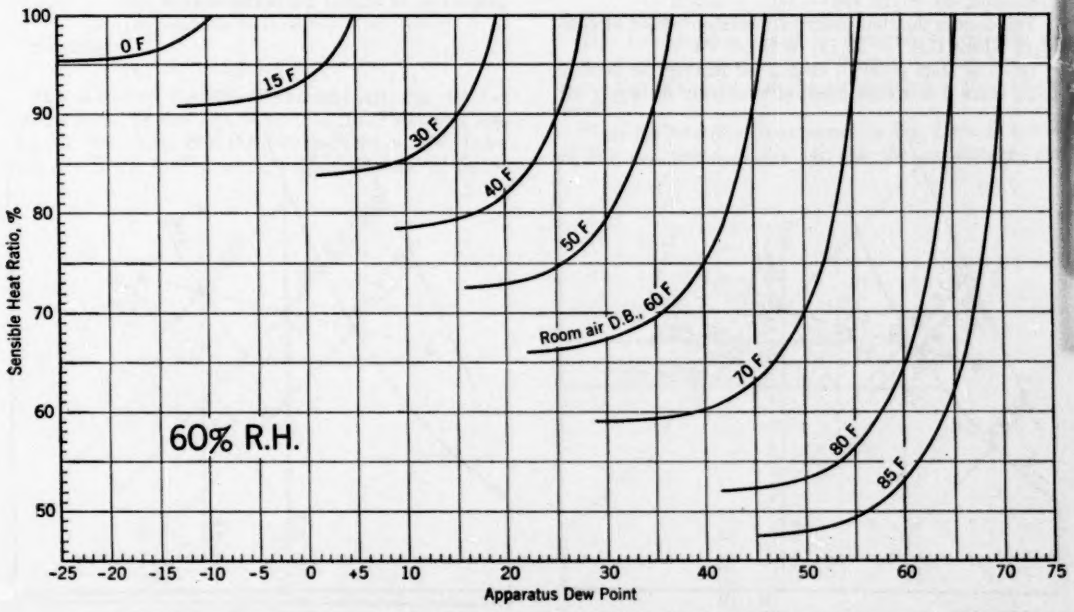


Fig. 14. Chart for finding apparatus dew point to maintain room at 60% R. H. and various dry bulb temperatures (marked on curves) with loads at various sensible heat ratios.

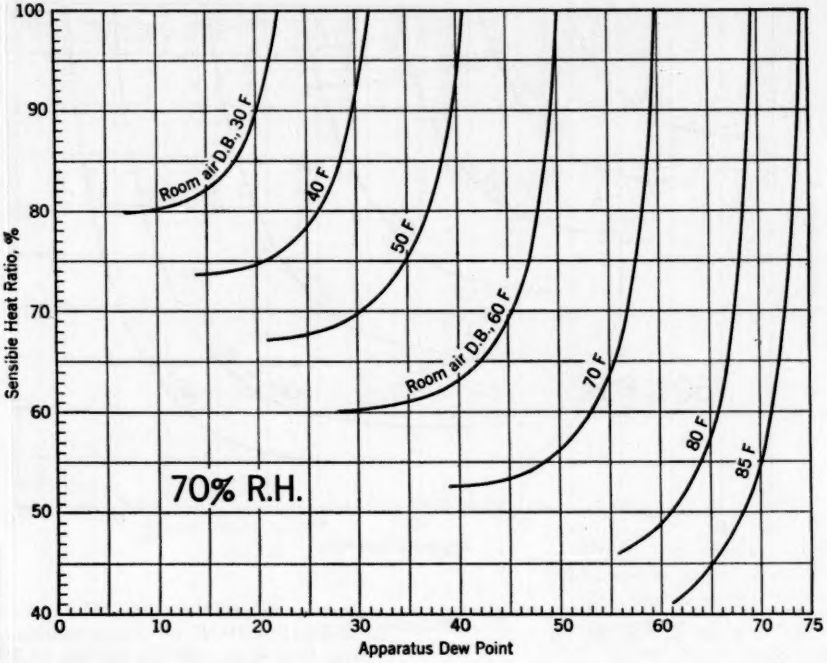


Fig. 15. Chart for finding apparatus dew point to maintain room air at 70% R. H. and various dry bulb temperatures (marked on curves) with loads at various sensible heat raitos.

This locates the dry bulb of supply air at (80 — 15) = 65F and the state point of supply air at *C* where the wet bulb can be read as 60.7F W.B.

(b) Locate outside air condition on chart at *D*. Fig. 20. Mixture of outside air and room air ahead of coils will then locate on line *A—D*.

Dry bulb of the mixture will be, according to previous discussion, 80 + .25 (95 — 80) = 83.75.

This locates the state point of return air ahead of coils at *E*, where D.B. = 83.75; W.B. = 70.

(c) The state point of chilled air leaving the cooling coils, since it is a component of a mixture of supply air and by-passed return air will lie on a line including points *E* and *C*. The intersection of this line with the 90% R.H. curve locates the condition of chilled air at *F* where D.B. = 59.4 W.B. = 57.6.

(d) The mixture of chilled (*F*) air and by-passed (*E*) air makes up the 3,000 cfm of supply air in proportions determined by the dry bulb intervals between them. The proportion of chilled air is therefore

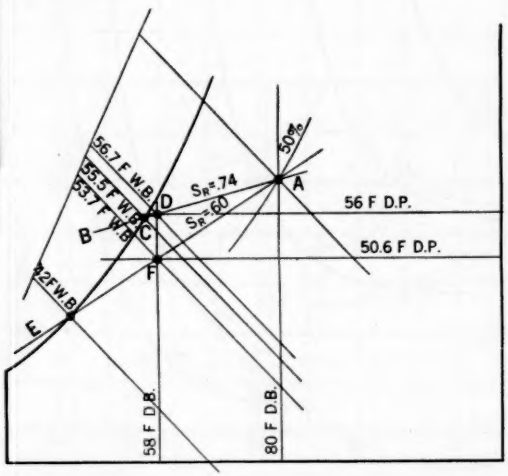


Fig. 16. Influence of S_R on A_{db} and supply dew point at constant supply and room dry bulb (examples 1 and 2).

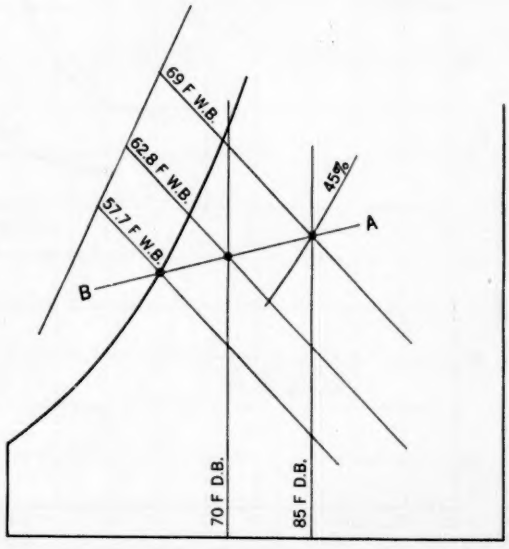


Fig. 17. Finding state point of supply air from specified volume (example 3).

$$\frac{83.75 - 65}{83.75 - 59.4} = \frac{18.75}{24.35} = 77\%$$

.77 x 3000 = 2310 cfm chilled air

(e) 3000 — 2310 = 690 cfm by-passed air.

It may happen that a room with an exceptionally large latent heat gain, such as a dance hall, will have a very low sensible heat ratio so that the slope of the supply condition line may be so steep that it does not intersect the saturation curve. In that event, the apparatus dew point can not be established directly from the Herkimer chart for the room condition, because each point on those charts represents a point on the saturation curve.

In such cases, use is made of the fact that sensible heat ratio lines are approximately parallel for a given ratio when drawn for any state point on the chart. That is, if the apparatus dew point for the problem conditions can not be found on the saturation curve (and hence does not appear in the Herkimer charts), any other room conditions with the same sensible heat ratio can be substituted to establish the slope of the supply air condition line. A line parallel to the substitute line can then be drawn through the desired room conditions.

If the proper line thus established is too steep to include the state point of chilled air leaving the coils, some means of reheating the chilled air must be devised, as in the following example.

(7) Given: $H_s = 141{,}000$
$H_L = 179{,}000$
Room: 80F D.B., 50% R.H.
Air leaving coil is 90% R.H.

Find:

(a) state of air leaving coil requiring the least possible amount of additional sensible heat
(b) state of supply to room
(c) volume of supply
(d) sensible heat required for reheat

Solution:

(a) $S_R = 47\%$.

This is not on the 50% Herkimer chart, Fig. 13, but can be found on the 70% chart, Fig. 15. Therefore, find A_{dp} for 70% R.H., 80F D.B., 47% S_R to be 58F. Draw line A^1—B^1, is in Fig. 21, representing slope of S_R = 47%, and draw line A—B parallel to A^1—B^1 and through the room condition.

This is the condition line of air supply to the room.

The point on the 90% R.H. curve requiring least addition of sensible heat to satisfy conditions on A-B is on a tangent from A to the 90% curve. Draw tangent A—C and locate chilled air condition at D. The chilled air from the coil is thus found to be at 36.5F D.B., 35.5F W.B.

(b) Sensible heat will be added at constant humidity along the horizontal coordinate from D which intersects the room condition line at E. Supply air will then be at 51.5F D.B., 43F W.B.

(c) $$Q = \frac{141{,}000}{1.1\ (80 - 51.5)}$$

(d) sensible heat for reheat will be

$H_s = 1.1 \times 4{,}500 \times (51.5 - 36.5) = 74{,}250$ Btu per hr.

Notice in Fig. 21 that air in any condition along the 90% R.H. curve below the level of point A can be sensibly heated to a point on the A—B line. Above point D, however, the increase in volume of supply air required will more than offset any possible decrease in the dry bulb range over which it must be heated. Below point D, of course, the converse is true.

For example, if the most economical coil arrangement to handle the conditions in the previous problem were found to be one that would cool return air to 49.5F D.B. and 48F W.B., reheat would follow the line F-G. Reheated supply would then be at 61.75F D.B., and the required quantity would be

$$Q = \frac{141{,}000}{1.1\ (80 - 61.75)} = 7{,}730 \text{ cfm}$$

The heat required for reheat would be

$H_s = 1.1 \times 7{,}730 \times (61.75 - 49.5) = 104{,}400$ Btu per hr

Refrigeration Capacity Required

The refrigeration plant is required to remove an amount of heat equal to the difference in total heat between the chilled air and the air supplied to the coil or washer.

Since the total heat coordinates in Fig. 1 are in terms of Btu per pound of dry air and the air streams are

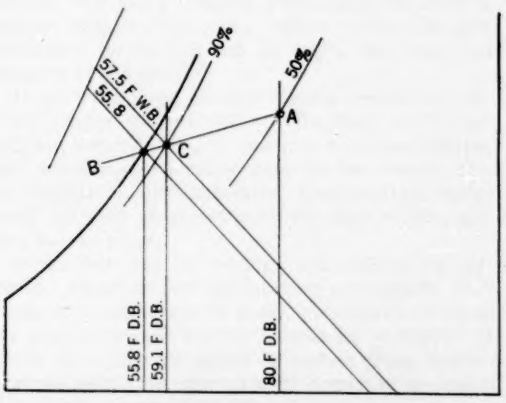


Fig. 18. Finding supply condition from chilled air condition (example 4).

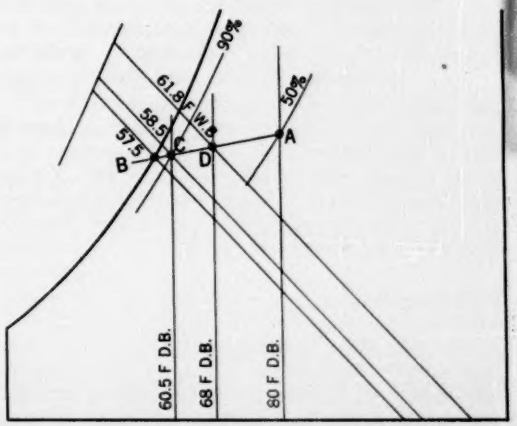


Fig. 19. Finding amount of by-passed air (example 5).

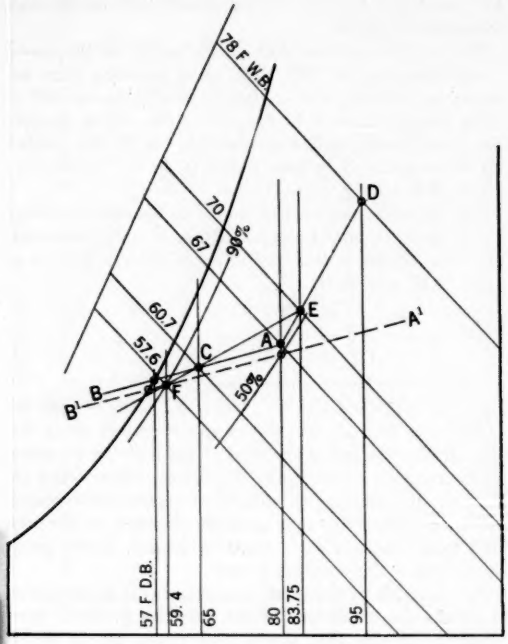


Fig. 20. Mixing outside and return air (example 6).

calculated in cfm, it is convenient to convert again in terms of standard air at 13.34 cf ft per lb.

Thus the weight of air treated is

$$W = \frac{60}{13.34} Q = 4.5\ Q$$

and the total heat removed is

$$H_T = 4.5\ Qh_T$$

Where h_T is the difference in total heat in Btu per pound of air before and after the coil.

The capacity of a plant may be expressed in tons of refrigeration using the factor, 1 ton = 12,000 Btu per hr. Thus, in tons, the capacity required is $H_T/12000$.

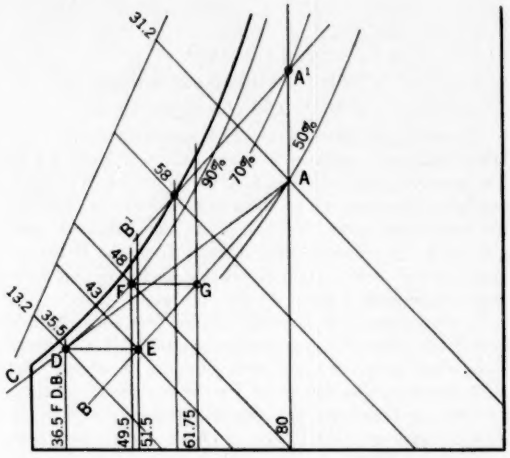


Fig. 21. Steep condition lines and reheat (example 7).

In the example illustrated by Fig. 21, the return air ahead of the coils is at state point *A* (total heat, 31.2 Btu per lb) and emerges from the coils at *D* (13.2 Btu per lb). The plant capacity is therefore

$$H_T = \frac{4.5 \times 4500 \times (31.2 - 13.2)}{12{,}000} = 30.5 \text{ tons}$$

Where the heat for reheating is extracted from return air by a means of a sensible heat exchanger (never by mixing the air streams) the total heat involved would be calculated between the points *A* and *E* in Fig. 21.

There are many types of problem which can be handled by using the psychrometric chart. Most of the principles have been outlined, and will apply in any procedure where the properties of moist air must be controlled. While most of the examples have been for cooling and dehumidifying, the principles involved are the same for heating and humidifying.

Experience is my Classroom

By T. W. REYNOLDS

EDITOR'S NOTE. Mr. Reynolds concludes the subject of servicing, trouble jobs, maintenance and similar problems, begun in the May, 1951 issue.

Ceiling Air Diffusers

The ceiling air outlet is blamed for most anything. It's an air diffuser, but like a pump which must have something to pump, it must have air of the quantity and temperature it is designed for. It has no control over the ducts. Workmanship of the ducts varies with the job and the installer. There are the inevitable changes and interferences, and there are ducts that are designed with or later have acoustical linings with no allowance for greater resistance or reduction of duct area.

Consequently, the ducts end up for various reasons with a resistance other than calculated, greater or less. This affects the air delivery of the ducts, air diffusers and air conditioning units. Why should not this inevitable change in resistance be anticipated on every job and later voluntarily compensated for, even when the engineer does not specify the possibility? Sometimes the installer does not bother to take readings at the outlets and no one bothers to check whether or not he has. Other installers will take an instrument and carefully record the air volume of each outlet, but consider themselves in no wise obligated to go further and adjust the fan speed where air quantities and resistances are not in accord with the plans.

Why not change the sheaves at the fan as required and consider this just as customary part of the contract? Why not check for belt slippage when the duct resistance is too high? The belt may be slipping as much as 50%, or the fan may be running backward. Finally, why not a common denominator for testing ceiling outlets? Why not a method which will give reasonable results and not vary with the ideas and opinions of the tester?

If it's noise in an air conditioning system, the offhand opinion will be that it's the fault of the air diffuser, yet it is hard to persuade the manufacturer that his outlets are noisy when he has tested them for noise in his own laboratory. Fans, or other equipment not even connected with the duct system may well be the cause.

A fan belt may be wobbling and striking its belt guard. Large outdoor air dampers not properly stiffened will vibrate and be noisy, particularly so when the weather is such that the outdoor air is stepped up above 25%. The air passed at certain times may be high as 100%, but even at 25% it may be too much due to high internal heat gain.

Noise will also come about from poor design or construction of duct work, more air than the fans, outlets or ducts were designed for; or from baffles, obstructions, rags or bolts left in the ducts. Since ducts provide such convenient places for temporary storage, we may also find some tar paper which has worked along partially to block the equalizing dampers at some outlet. They call these things job conditions. They are usual, but should be unusual.

Misapplication of product, a big factor of trouble with any equipment, is especially prevalent with the design or installation of outlets. They get under- or over-sized. All outlets in a single open area are sometimes made the same size for uniform appearance. This can be done in some areas without trouble, provided the outlet size is kept within the maximum high or low of the proper air delivery of the outlets. Large outlets tend to be scratched up by dragging them along when they should be carried. Shelving or fixtures may disturb the normal air pattern or flow from an outlet. There should be an unobstructed distance of at least one foot below them.

If one does not understand how to assemble an outlet with its dampers and neck connection to duct work, as sometimes happens in remote localities, a combination of curious things may ensue. Discarding instructions, he will work harder by assembling in his own wrong way and in this way make it even harder for someone else to untangle the knot. He may omit the cotter pins, throw away the bolts, and install the equalizing dampers in place upside down and backward also; then, to top it all he may do a good job of riveting the dampers in place. One such outlet was so found on a job and when the worker was questioned, he reported that he was careful to do them all alike. Well done, thou good and faithful servant. As for us, we slaved for six weeks removing his rivets and righting things. I shall never forget that job. It was a new low in forty years of trouble experience.

I have found adjusting rods installed above the dampers, so that the inner assembly of an outlet had to be removed before use could be made of the adjusting rod. When an assembly is wrong some dampers work improperly, others must be forced so hard that parts are broken, while still other dampers cannot be adjusted at all. Some outlets will be found without any dampers.

When an equalizing damper is installed upside down, the streamlined beaded edge will be on the down side of the air flow, thus projecting the thin edge of the adjusting blades into the air stream to vibrate and make noise from lack of streamlining. When the dampers are installed backward the blades are parallel with the air flow, thus doing no equalizing at all. The

blades should be run at right angles to the flow in the duct, the same as with duct turns.

The neck extension to an outlet may be found too small, may be bent in order to fit the outside of the neck of the outlet rather than the inside, thus forcing the adjusting rod off center; or the neck extension may be short so that the air stream from the duct has no opportunity to straighten out before the outlet receives the air. There is also a tendency today to design more duct work exposed and therefore to eliminate air straightening devices ahead of outlets. The effect of this practice is most noticeable if the outlet is of the register type. In this case all of the air delivery will be crowded through one-half of the outlet at double the normal velocity, while the other half of the outlet will be under a vacuum.

With a ceiling air diffuser, the familiar blank-off baffle is too frequently used as a cure-all for all troubles. It often is a cure, but baffling can be overdone. A baffle of sheet metal or even cardboard is quickly made and easily inserted to block off one or more quarters of the cones, depending upon how many nearby posts or beams there are to deflect the air delivery down upon some occupant. Of course, one can baffle a ceiling outlet to a greater extent than he can a register because the circular outlet has an air delivery through cones and around a periphery of 360°, but unfortunately it is often forgotten that with increase in baffling the remaining cone area discharges more air and this to a more limited occupied space.

The outlets being the only visible evidence of the air conditioning system, they are blamed when the space is held at too low a temperature, or when the delivered air is much too cold. In one case an occupant at a desk too close to the window complained of drafts on the back of his neck during the winter months. Window drafts and body heat lost by radiation to the glass were the real cause of his complaint, so that this "draft" was soon remedied by closing the venetian blinds at the window. This complaint was made in Washington, and the individual was former Secretary of War Stimson.

• WHAT NEXT?

The wealth of new devices appearing each year in our technical literature is stimulating to those who have had to go without such convenience for so many years. In a review of trade literature for the past year, devices that particularly appeal are:

(1) An electric mat to localize chilly working areas and thereby increase the efficiency and comfort of the worker; (2) electric baseboard panels; (3) wall registers with individual automatic control; (4 and 5) reversible fans; (6) steam traps with glass ports to give visual control of trap operation. One also reads about portable radiators, finds an ever increasing number of garbage disposers for the sink, learns about motor-driven wheelbarrows that negotiate up to a 40% grade and (7) a drain gun for clearing sinks and drains at 50 lb pressure using a carbon dioxide cartridge.

One is informed on utilization of fly ash (a by-product); a gas so purified that its products of combustion may be used directly for heating in factories; also how air conditioning ducts were run outside of a building in a novel and pleasing manner.

The electric baseboard panel, which replaces the ordinary baseboard in a house, is fully automatic in operation and consists of a steel frame encasing a glass panel. The surface temperature reaches about 240F because of an element fused into the back surface of the panel.

Of two different makes of reversible fans, the Hartzell is for periodic reversal to provide uniform drying in a lumber kiln. Efficiency is the same in either direction; free air delivery is 20,000 cfm for the 36-inch fan powered by a 2 hp motor. The other is a window fan that exhausts or delivers air at the flick of a switch. It is obtainable in 18- and 22-inch sizes, with capacities 2,500 and 3,400 cfm, respectively. Speeds are high and low.

The purified gas is made so by a material named Carbocell (8) of which one pound treats 5,000 cu ft of gas fired in a direct-fired heater. This material is reloaded once a year. Obviously, the advantages of utilizing the entire heat release of the gas from the heater directly into the occupied space are economy and quick heating. It is now so used in factories in England and its use is proposed for intermittent heating of churches, assembly halls and restaurants. Another English manufacturer has marketed gas fired equipment to utilize directly the products of combustion, but in this case without purification, since application is solely for drying.

The air conditioning ducts previously mentioned, together with the necessary chilled water and drain pipes, are run inside of aluminum fins on the exterior of the Employers Insurance Building, Dallas, Texas. The system is steam absorption and the fins are primarily for architectural treatment.

Although fly ash collectors are increasing in number and efficiency, pulverized coal and spreader stoker firing are making more fly ash than people want in the atmosphere. So research has become rather intensive in finding ways to obtain greater returns for the expensive collection of this ever increasing item.

While no company has found markets for all of this ash, research is improving its application as a substitute for Fullers earth in rubber, pumice in mechanics' soap, sand in fertilizer, limestone or silica dust in asphalt, and sandblasting of condenser tubes. It is used also in cinder concrete as well as in the filtering of dirty oils.

By checking back to the reference number, one can find the manufacturer of the item from the following list:

(1) Walter B. Snook Enterprises, Palo Alto, Calif.
(2) Appleman Glass Works, Bergenfield, N. J.
(3) General Electric Co., Bloomfield, N. J.
(4) Hartzell Propeller Fan Co., Piqua, Ohio.
(5) Hunter Fan & Ventilating Co., Memphis, Tenn.
(6) Velan Engineering Co., Jersey City 2, N. J.
(7) Handling Devices Co., Inc., Boston, Mass.
(8) National Smelting Corp., Avonmouth, England.

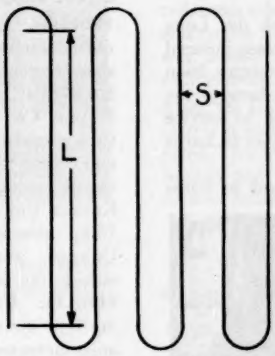
Pipe Required for Radiant Heat Coils

R. K. DEMAREST, JR.

The accompanying chart has been designed to facilitate finding the linear feet of pipe required for panel heating coils of the type shown in the drawing, where L is the length of straight run, in feet, and S the spacing in inches between runs. The table gives the number of feet of pipe in the bends; to this is to be added the straight runs.

Following is an example of use of the table:

Problem. Assume a coil as shown in the drawing, S being 18 inches (center-to-center spacing) while L, the length of straight run, is 5 feet. How much pipe is required for the coil?



Solution. Count the number of bends (six) and the number of straight runs (seven). The straight pipe needed is then 7 x 5 feet or 35 feet. Refer to the table and under 6 (number of bends) and opposite 18 (inches spacing) find 14.18 lineal feet of pipe in the bends. Total pipe required is then 35 + 14.18 = 49.18 feet.

Pipe Spacing, S, Inches	Number of Bends									
	1	2	3	4	5	6	7	8	9	10
	Lineal Feet of Pipe in Bends									
6	0.785	1.57	2.35	3.14	3.93	4.71	5.50	6.28	7.06	7.85
8	1.047	2.09	3.14	4.19	5.23	6.28	7.33	8.38	9.42	10.47
9	1.18	2.36	3.54	4.72	5.90	7.08	8.25	9.44	10.61	11.80
10	1.31	2.62	3.93	5.24	6.55	7.86	9.17	10.48	11.80	13.10
11	1.44	2.88	4.32	5.76	7.20	8.64	10.08	11.51	12.95	14.40
12	1.57	3.14	4.71	6.28	7.85	9.42	11.00	12.56	14.13	15.70
13	1.70	3.40	5.10	6.80	8.50	10.20	11.95	13.60	15.30	17.00
14	1.83	3.66	5.50	7.32	9.15	11.00	12.80	14.63	16.43	18.30
15	1.96	3.92	5.88	7.84	9.80	11.73	13.70	15.65	17.63	19.60
16	2.09	4.18	6.27	8.36	10.42	12.50	14.60	16.70	18.80	20.90
17	2.22	4.44	6.66	8.88	11.10	13.35	15.55	17.75	20.00	22.20
18	2.36	4.72	7.08	9.44	11.80	14.18	16.50	18.90	21.23	23.60
19	2.49	4.96	7.47	9.96	12.41	14.60	17.40	19.40	22.40	24.90
20	2.62	5.24	7.86	10.48	13.12	15.75	18.40	21.00	23.60	26.20
21	2.74	5.48	8.22	10.96	13.70	16.42	19.20	21.90	24.65	27.40
22	2.88	5.76	8.66	11.55	14.40	17.30	20.20	23.10	26.00	28.80
23	3.01	6.02	9.03	12.02	15.03	18.10	21.10	24.10	27.10	30.10
24	3.14	6.28	9.42	12.56	15.70	18.80	21.95	25.15	28.20	31.40
25	3.28	6.56	9.84	13.12	16.40	19.70	23.00	26.25	29.50	32.80
26	3.40	6.80	10.20	13.60	17.00	20.40	23.80	27.20	30.60	34.00

Pipe Spacing, S, Inches	Number of Bends									
	11	12	13	14	15	16	17	18	19	20
	Lineal Feet of Pipe in Bends									
6	8.64	9.42	10.20	11.00	11.78	12.55	13.35	14.13	14.90	15.70
8	11.50	12.57	13.60	14.60	15.70	16.74	17.80	18.85	19.89	20.94
9	12.97	14.15	15.32	16.50	17.70	18.88	20.03	21.10	22.40	23.60
10	14.40	15.70	17.01	18.34	19.65	20.95	22.25	23.55	24.90	26.20
11	15.85	17.28	18.72	20.15	21.60	23.00	24.50	25.96	27.35	28.80
12	17.30	18.82	20.40	22.00	23.50	25.10	26.70	28.25	29.80	31.40
13	18.70	20.40	22.10	23.80	25.50	27.20	28.90	30.60	32.30	34.00
14	20.15	22.00	23.75	25.60	27.50	29.25	31.11	33.00	34.80	36.50
15	21.50	23.50	25.50	27.45	29.40	31.35	33.25	35.25	37.20	39.15
16	23.00	25.00	27.20	29.20	31.25	33.40	35.50	37.50	39.65	41.75
17	24.45	26.60	29.85	31.10	33.35	35.55	37.75	40.00	42.20	44.40
18	26.00	28.30	30.65	33.00	35.45	37.75	40.10	42.50	44.80	47.20
19	27.35	29.85	32.25	34.80	37.25	39.75	42.30	44.75	47.35	49.65
20	28.80	31.50	34.10	36.70	39.35	42.00	44.60	47.20	49.80	52.40
21	30.15	32.80	35.60	38.40	41.10	43.85	46.60	49.30	52.00	54.80
22	31.70	34.60	37.50	40.40	43.20	46.15	49.00	51.90	54.85	57.80
23	33.15	36.15	39.10	42.15	45.20	48.15	51.20	54.20	57.20	60.20
24	34.50	37.60	40.75	44.00	47.00	50.10	53.25	56.50	59.60	62.80
25	36.10	39.45	42.70	46.00	49.25	52.60	55.85	59.10	62.40	65.60
26	37.45	40.85	44.20	47.60	51.00	54.50	57.90	61.30	64.60	68.00

PRODUCT APPLICATIONS

New, Unusual, or Ingenious Uses of Equipment and Materials

Conducted by WM. B. FOXHALL, Associate Editor

Fan Insulation Prevents Burns

PROBLEM: At the Glenwood Gas Plant of the Long Island Lighting Co., rooftop fan housings enclose induced draft fans which draw waste gases at temperatures from 600 to 700F from boilers through exhaust ducts to the surrounding air. Maintenance men required to service exposed parts of cracking furnaces were subject to burns from accidental contact with equipment.

SOLUTION: Fans and fan motors are enclosed in housings which are covered with mineral wool blanket insulation up to about 5 ft above roof level. The top portions of the stacks are high enough to be left uninsulated. Blanket insulation was also applied to indoor sections of exhaust ducts. The 2-inch mineral wool blankets were secured to the sheet metal housings by welded wires approximately 3 inches long. The blankets, with wire netting on the inside, were impaled on the wires and the ends of the wire were bent over into the metal lath covering the outside of the insulation. A ⅝-inch layer of mineral wool insulating cement was troweled into the metal lath and a finishing cement was applied with wire netting fitted over the surface and tightly laced. A weatherproof finish was provided by a ¼-inch coat of asphalt.

RESULTS: Maintenance men are able to work in the area without danger of accidental burns. Increased temperature of flue gas helps fans maintain draft.

Automatic Controls Insure Pump Operation

PROBLEM: The city of Park Ridge, Illinois obtains its water from Chicago and, since it has no elevated tank or standpipe, must depend on pumps to circulate water from an underground reservoir. Manual control of pumps was costly and emergency equipment was lacking.

SOLUTION: The system was converted to automatic pump control by installation of an Autocon system supplied by Automatic Control Company. The controls operate through pressure impulses received from a monitor system in the service lines. Water pressure is not permitted to drop below 48 lb per sq inch. When useage is up and pressure starts down, the Autocon selects and puts into operation additional pump capacity. A Diesel engine is installed as a standby power source.

RESULTS: Savings in operation expense were $10,000 per year. The entire water system remains underground and safe from contamination or enemy attack. Emergency operation for fighting fires and continuing use of sanitary facilities is assured.

Direct Expansion Cooling Boosts Sales

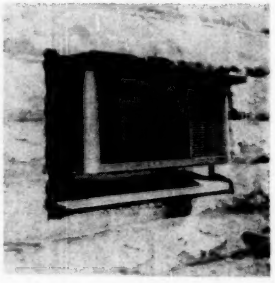
PROBLEM: A Canton restaurant in Atlantic City required summer air conditioning without the use of floor space or cooling water.

SOLUTION: Equipment installed by the Atlantic Store Fixture Co., of Atlantic City consists of two Kramer ceiling type air conditioning units, three 5-ton Kramer Unicons and one 15-hp compressor. The Unicons were installed outside the building.

RESULTS: Use of ceiling type air conditioning units increased seating capacity of the restaurant by eight persons, since floor models would have occupied two booth spaces. Remote installation of Unicons eliminates compressor noises and permits servicing without interference with normal operation of the dining space.

Window Conditioner Helps Candy Manufacture

PROBLEM: The G. B. Graver plant in Glendale, Queens, New York, where candy, cookies, and candied nuts are manufactured, is housed in a converted garage. The building had been plagued by high humidity during the spring and early fall months and was closed during July and August. Humidity caused the candy to become sticky and lose its gloss, shape, and body and made cookies and nuts soggy. Cutting and packing were extremely difficult, and storage was hazardous. The location of the only two windows in the building, close to the sidewalk and about 5 ft above the ground, precluded conventional installation of a window type conditioner.

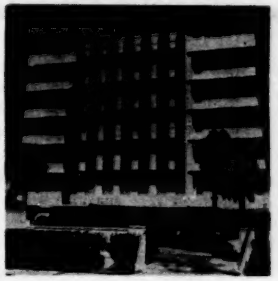


SOLUTION: A facsimile of a window frame was built into an opening in the 10-inch concrete block side wall and fitted with a ¾-ton usAIRco window unit, product of United States Air Conditioning Corp. Adjustable louvers permit the flow of cooled air to be directed toward the area where most of the candy is stored.

RESULTS: Manufacture and storage of candy is possible over longer periods of the year. Filtered air from the conditioning unit is an aid to plant cleanliness. The equipment is used in winter months for ventilation and exhaust.

Window Units Cool Hotel

PROBLEM: In the design of an air conditioning system for the Tatem Hotel in Miami Beach, individual control of room conditions was desired without recourse to an extensive piping system. It was further desired to provide air conditioning only during periods of intermittent occupancy of rooms.



SOLUTION: Simple plug-in type ¾-ton Mitchell window units were installed, one each per room. Capacity of each machine is 9050 Btu per hour. Air is filtered and dehumidified and is mixed with outside air.

RESULTS: Individual control, easy mounting, and simple installation provide a flexible system without central piping system.

Portable Cooling Units Follow Machinery Load

PROBLEM: An unpredictable cooling problem posed by heavy heat producing calculating machines hinges on the fact that machines may be moved from one part of a new insurance building to another. The recently completed and centrally air conditioned office building of the New Hampshire Fire Insurance Co., in Manchester, New Hampshire, has installed its IBM calculating equipment in one of the rooms on the first floor. However, since the machines are completely self-contained, they can be moved to other locations in the building, which would radically change the air conditioning load both in the space to which they were moved and the room that was vacated.

SOLUTION: To handle any possible future changes without alterations in the built-in central system air conditioning, two Carrier packaged Weathermakers sized to take care of the heat from the calculating machines alone were prescribed. The Weathermaker units, which are also completely self-contained, will be moved wherever the IBM equipment goes. All other loads in the building will be handled by a central system.

RESULTS: System was built to be designed without reference to movable periodic loads. Central equipment was reduced in size. Operating expense of periodic machinery load is scaled to actual needs.

Radioactive Isotope Spots Plumbing Leak

PROBLEM: A new ranch-type home was known to have a substantial leak in the plumbing beneath its cement floor. Evidences of moisture could be observed in the vicinity of the adjoining bath and kitchen. Radiant heating pipes were buried in the floor.

SOLUTION: After the main water line was disconnected radioisotope application engineers of Radioactive Products, Inc., introduced 2 millicuries of radioactive Iodine. Water was gradually poured in on top of this so that the material would be forced into the plumbing system beneath the house. Delicate survey meters were positioned over the main branches of the plumbing and the point of leak indicated by the direction of flow and final point of loss of the material from the line into the ground. Results indicated this leak to be located at a tee leading from the main line to the bathroom commode. Non-radioactive Iodine was then added to the line to dilute and render harmless the radioactive material. More water was flushed through the line to clear it completely of radioactivity.

RESULTS: The floor was opened with a hole of approximately 6 inches in diameter at the point of leakage indicated. Two holes were found in the copper piping approximately two inches from the tee junction. Thus no extensive breakup of flooring was required.

Cooler on Shelf Saves Store Space

PROBLEM: During World War II, heavy demand for store space on Third St., in downtown Baton Rouge, La., resulted in the expedient of enclosing a small dead end alleyway to provide space for a small shoe store. A small window with a glass door 2½ feet wide and 6½ feet high formed the front and only means of entrance, ventilation and light. Solid side and rear walls of brick with occupied offices above and a concrete slab floor without any basement underneath posed more than the usual problem when air conditioning was required. A survey showed that while the heating load was small, the cooling requirements were slightly in excess of a ton of refrigeration.

SOLUTION: A Frigidaire remote type room air conditioner of 15,000 Btu per hour capacity was installed flush in the shelving near the ceiling. The top discharge grille was altered with a small duct for side air distribution. As outside gas venting was impossible under the building code, four 1500-watt strip type electric heaters were mounted in the duct extension. Thus, the unit provides heat for winter comfort as well as refrigeration in summer. A combination air and water cooled Frigidaire reciprocating 1½-h.p. compressor was mounted in a second-floor lightwell. This unit uses water only when the ambient air is 90F or higher; other times it is air cooled.

RESULTS: Despite the fact that the small store is frequently crowded by customers, George Baudry, proprietor, reports that adequate cooling is provided at all times. Ventilation is provided by natural infiltration through the normal opening and closing of the front door. So successfully did the system solve the air conditioning problem at the small store, Mr. Baudry has installed larger year-around systems of the same design in two other shoe stores which he owns and operates.

What Would You Do?

Replies to engineering and operating problems of interest to the industrial plant engineer

Conducted by
NATHAN N. WOLPERT
Associate Editor

This Month's Problem

How do you determine what per cent of lubricating oil of one viscosity must be mixed with that of another viscosity in order to obtain an oil of desired SSU grade? Is there a formula or chart for solving such problems?

THIS department is devoted to problems of interest to the industrial plant engineer. Each month some problem is featured that is believed to be of current value to a large group of engineers.

Should you have a problem that you would like to see discussed in this department, or if you have some comments that you would like to contribute to the problems to be discussed in coming issues, you are invited to write to the editor. Such letters will be most welcome.

Solution

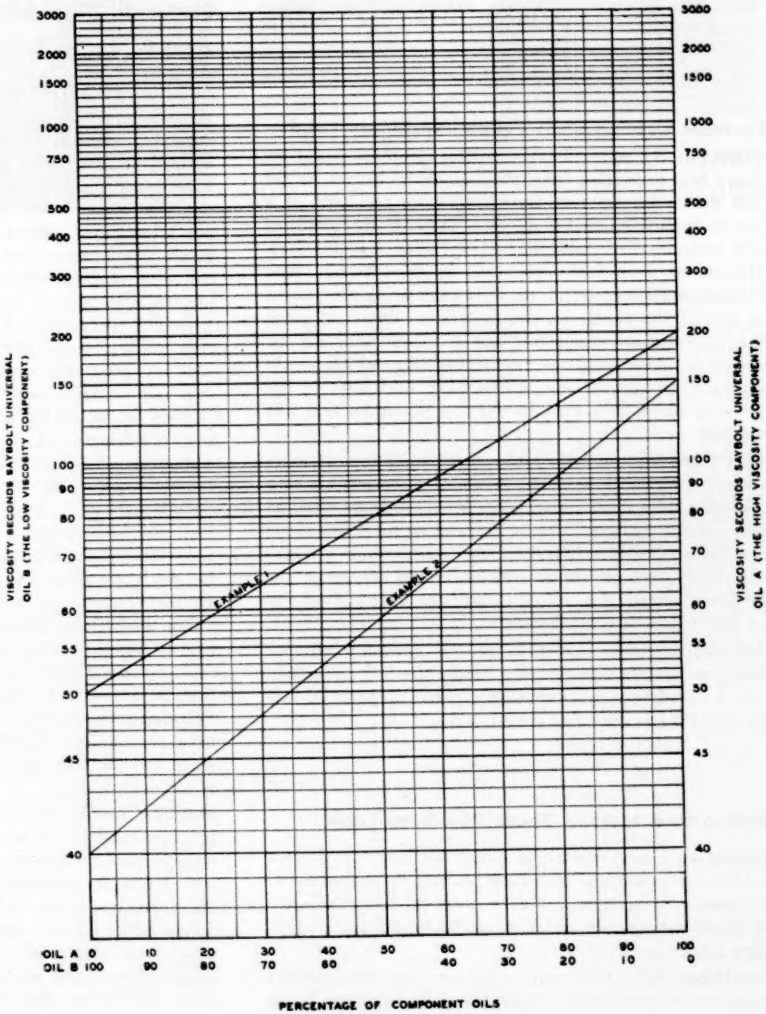
The following information was received from Allen F. Brewer, Technologist, The Texas Co., in answer to the problem.

The blending chart, illustrated on this page, represents the viscosity range ordinarily encountered in practice. The viscosity of both oils is taken at the same temperature. It should be remembered that any chart, at best, is but a close approximation with the discrepancy increasing with the difference in viscosity of the two oils being blended.

The following two examples will clarify how the chart can be used in solving problems dealing with the blending of two oils. The chart is easy to use.

Example 1

How much oil at 50 SSU at 100F (oil *B*) must be blended with a 200 SSU oil at 100F (oil *A*) to give a 100 SSU oil?



Viscosity blending chart.

Problem for January Issue

We have a 10 x 12 ft door opening close to a production area in an industrial building. How would warm air curtains be used to keep out cold air when the truck doors are open? Are they effective in checking entrance of cold air?

Problem for February Issue

Because of the large amount of abrasive material present in the air of our foundry, normal duct design and installation cannot be used. What can you suggest for us to follow that would prolong the life of the ducts and possibly increase their efficiency?

Draw a line between the 50 and 200 viscosity points on the respective zero lines. Note where this line crosses the 100 viscosity horizontal. The answer is 36% of 50 viscosity oil (oil *B*) and 64% of oil *A*—the 200 viscosity oil.

Example 2

What is the viscosity of a blend of 20% of a 40 SSU at 100F oil (oil *B*) and 80% of a 150 SSU at 100F oil (oil *A*)?

To solve this problem, draw a line connecting 40 viscosity on the oil *B* line and 150 viscosity on the oil *A* line. This line crosses the 80% line (oil *A*) at 94 and indicates that 94 SSU at 100F is the viscosity of the desired blend.

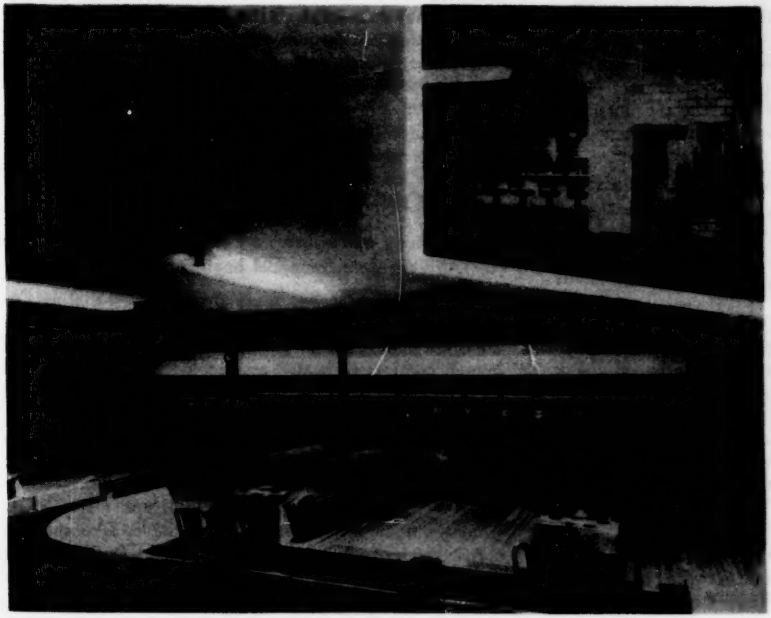
Bowling Alleys Have Year-Round Comfort

A year-round air conditioning installation for the Bonnie Lanes Bowling Alley, Sandusky, Ohio, called for considerable flexibility. Bell Refrigeration Corporation, Cleveland, met this with two packaged Typhoon units in hidden or recessed locations.

A large billiard room running next to the alleys is air conditioned and heated by a 3-ton console unit built in to the glazed block wall of the billiard room, with only the front panel showing. Concealed ductwork from the unit supplies four diffusers in the ceiling. A heating coil in the console unit provides heat through the same ducts in winter.

The bowling alleys, a lunch room, the lobby, and offices across the front of the building are air conditioned and heated by a 15-ton unit equipped with a 2-row heating coil. This unit is located in a storage room next to the lunch room.

A Typhoon oil-fired hot water boiler is located in the boiler room along with the 3-ton console unit. Two circulating pumps divide heating into two primary zones—one pump supplies the coils in the two air conditioners, the other pump supplies a wall convector in the pin boys' dressing room and two hot water unit heaters in the pin boys' pit behind the alleys. The two unit heaters are on a separate thermostat which starts and stops unit heater fans.



General view of the bowling alleys. Insert shows the 15-ton air conditioning unit in the storage room, next to the lunch counter. The screened panel to the right of door is for return air to the storage room.

NEWS OF THE MONTH

CONSTRUCTION CEILING PRICES

established by new regulation which cuts percentage markup but not absolute profit, says OPS.

The Office of Price Stabilization issued in mid-November a new ceiling price regulation designed to meet the specific needs of the construction industry generally. The new order, Ceiling Price Regulation 93, became effective November 20, 1951.

• **NEED.**—Previously, construction and related services and sales of installed materials were covered generally by the General Ceiling Price Regulation (GCPR) until the issuance of Ceiling Price Regulation 34 (Services) on May 16, 1951. Pricing under these regulations proved difficult and unsuited to the construction industry.

Except for actual increases in labor and material costs, it is not expected that the new regulation will result in any general increase in charges for construction work.

• **BASIS.**—In general, the new regulation establishes ceiling prices on the basis of current costs for labor, materials and equipment, plus nine-tenths (9/10) of the highest markup for profit which the seller had in effect for a similar job during the base period July 1, 1949 to June 24, 1950.

In reducing the base period percentage markup for profit by 10%, as provided in the new regulation, OPS officials pointed out that costs of construction labor and building materials have risen by 10% and 12%, respectively, since the outbreak of hostilities in Korea. It is estimated, therefore, that nine-tenths of the pre-Korean percentage markup for profit, when applied to increased costs, will result in approximately the same dollars-and-cents profit as the seller realized during the base period on a similar job.

The base period percentage markup for overhead need not be reduced if the seller can make a separation of his total base period percentage markup into an applicable percentage representing profit and an applicable percentage representing his recovery of overhead expense.

• **COVERED.**—The regulation covers transactions in which the seller furnishes labor service or any combination of labor, materials, equipment and service for building construction, highway construction, heavy construction, railroad construction, and a broad range of miscellaneous construction.

Also included are transactions which involve shop fabrication by the installer of materials; the sale of installation or erection service by a manufacturer who installs or erects a commodity manufactured by him and charges separately for the installation or erection; and any transaction involving both te manufacture and installation or erection of a commodity with a single charge for the entire service, except those transactions specifically covered by Ceiling Price Regulation 30 (Machinery and related manufactured goods).

Each type of construction service may involve the activities of contractors in specialized branches of the construction industry such as plumbing, heating, air-conditioning, electrical work, sheet metal work and carpentry. Accordingly, the regulation is designed to afford methods of general pricing applicable to all segments of the industry in order that sellers may price their services readily and uniformly and in accordance with traditional methods used by them in estimating and furnishing services, materials and equipment.

The regulation applies to sales of construction services under lump sum, cost-plus fixed fee, and cost-plus with guaranteed limit contracts; to sales on a time and materials basis or an hourly rate basis; and to sales of items or materials and equipment together with the construction services required to install or erect them.

• **EXCEPTIONS.**—An exception to the general pricing method provided in the regulation is made in the case of sales of labor services on the basis of an hourly rate charged to the purchaser. The ceiling charge for labor services cannot exceed the highest base period hourly charge plus the dollars-and-cents increase in the cost of that labor incurred by the seller subsequent to the base period.

A further exception is made in the case of sales of construction services under cost-plus fixed dollar fee contracts. The ceiling fixed dollar fee which may be charged is the highest fee charged during the base period for a similar job. Similar exceptions apply to sales on a time and materials basis and to installed sales.

The new regulation contains a savings provision allowing a seller to continue to use a ceiling price which he has properly established under the service regulation CPR 34, if that ceiling price is higher than the ceiling price allowed under the new regulation for the same service. If the seller elects to use a higher CPR 34 percentage markup, however, he may not then apply that higher percentage markup to current costs, except as otherwise provided by CPR 34. The higher CPR 34 percentage markup must be applied to costs on the December 19, 1950, through January 25, 1951 level.

ENVIRONMENT LABORATORY

to study human comfort opened in Cleveland by ASHVE; data for panel heating, cooling sought.

The American Society of Heating and Ventilating Engineers unveiled its new Environment Laboratory in Cleveland November 1. The laboratory will be used to study human comfort in heated and cooled indoor spaces and to develop data for the design and installation of panel heating and cooling systems.

• **STRUCTURE.**—It is a large room in which the temperature of all the room surfaces and portions of each surface can be controlled separately so that it is possible to simulate a variety of combinations of cold and warm walls, windows, floors and ceilings. For example, to simulate a corner room of a building, two walls can be cooled to the desired temperatures, while some of these walls can be held at a lower temperature to simulate glass areas.

The Environment Laboratory has been constructed at the general research laboratory of the ASHVE at 7218 Euclid Avenue. Preliminary planning began in 1948 and continued through 1949. Construction of the room was started in 1950. It is regarded as one of the most important of the society's tools for fundamental research.

Guests were received by Lauren E. Seeley, president of the ASHVE; Irwin W. Cotton, chairman of the society's committee on research; Cyril Tasker, director of research for the ASHVE; Peter B. Gordon, chairman of the ASHVE technical advisory committee on panel heating and cooling and C. S. Leopold, chairman of the TAC on sensations of comfort, who were instrumental in the development of the project, and other society officers and committee members.

So that the room could also be used for a study of the relationship between human comfort and radiation, it was designed to permit division into two rooms when desired. At present the room is not yet an environment laboratory in the fullest sense. Additional equipment will have to be provided and some fundamental changes made after the completion of panel heating studies in order to make it suitable for physiological studies.

• **EQUIPMENT.**—The room is approximately 25 feet by 12 feet, with a ceiling that is adjustable to heights from 7 to 12 feet. When divided in two, each room will measure 12 feet by 12 feet. The outer shell is of ¾-inch plywood on a light steel framework. The floor is three feet above the floor of the main ASHVE Laboratory (in which it is housed) to provide a crawl space for piping and wiring.

All interior surfaces of the room are formed of aluminum panels. Attached to the back of these panels are ⅜-inch cooper coils on 3-inch centers, connected to mains located in the crawl space.

The room has been designed to permit surface temperatures which may be encountered at outdoor temperatures as low as zero degrees F. Cold wall areas can be maintained at temperatures as low as 40 F.; simulated glass areas as low as 20 F. Floor and ceiling surfaces can be kept at any desired temperature up to 180 F.

Air can be supplied at simulated outdoor temperature for studying the effect of infiltration. Two changes per hour of air down to zero F. can be supplied to the room at simulated window locations. This air is treated in a sorption type dehumidifier and cooled to simulate dry outdoor air. The same system also furnishes dehumidified air to the crawl space and to the space between the wall panels and the outer shell to minimize condensation behind the panels.

The refrigeration compressor, heat exchangers, tanks, pumps and miscellaneous equipment necessary to supply liquid to the various panels are located in the lower ASHVE Laboratory immediately below the room. Separate pumps and piping systems are provided for the ceiling, floor, simulated cold wall areas, and simulated glass areas in the room.

• **INSTRUMENTATION.** — The instrumentation provided will permit readings of:

(1) Surface temperatures within the room by means of almost 400 thermocouples attached to the back of the panels.

(2) Air temperatures at any point in the room.

(3) The rate and temperature at which the infiltration air is supplied.

(4) How much heat is picked up or given off by all surfaces. This is measured by means of 175 heat flow meters, 11½ inches square, which were fabricated at the ASHVE Laboratory of bimetallic foil separated by plastic spacers.

Other instrumentation will be added to determine mean radiant temperatures; air velocities within the space; and the flow of heat from the air to any surface or vice versa.

Equipment will be added later which will permit maintaining air temperatures within the room independent of surface temperatures. This will permit the human comfort studies under varying internal dry bulb temperatures, relative humidities, and air change rates.

INDUSTRIAL HEALTH

gets annual checkup at conclave of experts of Industrial Hygiene Foundation.

Five hundred industrial officials from the United States and Canada were among speakers and guests at the 16th Annual Meeting—consisting of technical conferences and the general meeting—of Industrial Hygiene Foundation at Mellon Institute on Wednesday and Thursday, November 14 and 15.

Of the 43 speakers, 10 were from the Pittsburgh district. Subjects of speeches and conferences ranged from the use of radioactive materials in industry and "Recent Developments in Outdoor Air Pollution" to executive health. A panel discussion on executive health, with a diagnostician from Mayo Clinic, a psychiatrist from Pittsburgh and an industrial medical director taking part, was one of the highlights of the general meeting.

The executive health panel followed the keynote address by Don G. Mitchell of New York, president of Sylvania Electric Products, Inc.

Andrew Fletcher of New York, board chairman of the foundation and president of St. Joseph Lead Co., opened the general meeting with a review of projects of the foundation for the past year. Dr. Edward R. Weidlein, president of Mellon Institute, gave the address of welcome.

Five conferences attended only by representatives from member companies were held on November 14. These were arranged by the engineering, chemical, medical and legal committees of the foundation.

HEATING EQUIPMENT MEETING

with NPA develops suggestions for materials conservation; reviews proposed order.

Revisions of a proposed order aimed at conservation of critical materials were discussed by the Extended Surface Heating Equipment Industry Advisory Committee at a November 2 meeting with the National Production Authority, U. S. Department of Commerce.

The extended surface heating equipment industry manufactures unit heaters, unit ventilators, blast coils and convectors. A large part of its production goes into schools, hospitals and factories manufacturing defense items.

• **SIZES.**—The committee noted that the proposed order would reduce the number of sizes and types now being produced. However, this would not save materials because a customer might have to accept a larger size unit than he

really required if the exact size specified were not available, members said.

• **METALS.**—As an alternative, the committee suggested that limitations be placed on the permissible thickness of various types of copper tubing and of enclosure steel on baseboards, wall fins and convectors. It was also recommended that aluminum be eliminated from grills and wall boxes and that only steel (not aluminum) be used for blades of 20-inch and smaller propeller fans.

The committee recommended that NPA incorporate the suggested changes in the draft of a new order, which would then be circulated to the 133 manufacturers in the industry for their comments.

Industry spokesmen said many manufacturers already have voluntarily saved substantial amounts of critical materials. They asked that this conservation be considered by NPA when future allotments are made. NPA agreed to study the recommendations.

Reviewing the outlook for critical materials in 1952, an NPA spokesman said that the military demand for materials will probably reach its peak in the third quarter of 1952. By that time much of the industrial expansion program will have met its goals and the supply of steel and aluminum improved. This is not the case with copper, however, where there is no significant relief in sight, officials said.

In regard to the specific items used by this industry, NPA noted that steel sheet and strip, with the exception of galvanized sheet, were in good supply. The outlook for chrome stainless steel is also good, NPA said.

The committee recommended that all the products manufactured by the industry be given a single code number in the CMP "B" products list. At present two code numbers are used.

John A. MacKinnon, of the NPA Building Materials Division, presided.

• **MEMBERS.**—These committee members attended:

M. Noble, Aerofin Corp., Syracuse, N. Y.
Richard H. Nelson, American Air Filter Co., Inc., Moline, Ill.
Ray C. Edwards, Edwards Engineering Co., East Paterson, N. J.
C. W. Little, Fedders-Quigan Corp., Buffalo, N. Y.
C. G. Newton, Kritzer Radiant Coils, Inc., Chicago, Ill.
A. G. Dixon, Modine Mfg. Co., Racine, Wis.
Albert J. Nesbitt, John J. Nesbitt, Inc., Philadelphia, Pa.
Harold E. Park, Shaw Perkins Mfg. Co., Pittsburgh, Pa.
J. E. Reed, Sterling Radiator Co., Westfield, Mass.
E. A. Cline, The Trane Co., La Crosse, Wis.
J. H. Smart, Tuttle & Bailey, Inc., New Britain, Conn.
T. L. Arnold, Vulcan Radiator Co., Hartford, Conn.
H. S. Wheller, L. J. Wing Mfg. Co., Linden, N. J.
W. G. Schlichting, Young Radiator Co., Racine, Wis.

HUMIDIFIER ASSOCIATION

formed by members of warm air heating group to further complete winter air conditioning.

Formation of a new professional society to be known as the Humidifier Association has recently been announced by members of the executive committee.

The committee members are all executives of companies actively engaged in research in winter-air conditioning. They are: Marion Levy, Viking Air Conditioning Corp., Cleveland, Ohio; Arthur Evans, Skuttle Mfg. Co., Detroit, Michigan; Jack Carr, Maid-O'-Mist, Inc., Chicago, Ill.; and J. W. Galloway, Automatic Humidifier Co., Cedar Falls, Iowa.

Efforts of the Humidifier Association, as outlined, are planned for three separate branches of activity.

• **RESEARCH.**—Directing and encouraging both engineering and medical research into the proper method and the effects of the addition of controlled humidity to parched winter air. Cited, was the research completed by doctors at the University of Chicago. This project proved that a controlled atmosphere of 50% R.H. is lethal to germs that cause pneumonia, scarlet fever, sore throats and other ailments.

• **TRAINING.**—Instruction to warm-air heating dealers on the proper installation and sale of automatic furnace humidifiers.

No heating system is complete without controlled humidity, said the committee spokesman. The installation of a humidifier assures customer satisfaction with a furnace job.

• **EDUCATION.**—A consumer publicity campaign is being conducted to inform the homeowner of fuel saving, structure preservation, and health benefits which can be enjoyed by the low-cost addition of an automatic furnace humidifier.

Inquiries and suggestions are solicited by the association whose address is: The Humidifier Association, 312 Ferguson Building, Cleveland 14, Ohio.

NEW HAVEN AIR

to be studied by industrial hygiene experts as preliminary to anti-smoke ordinance.

Air pollution in New Haven, Connecticut, is being studied by experts of the Industrial Hygiene Foundation, Mellon Institute, Pittsburgh. Under the direction of W. C. L. Hemeon, engineering director of the foundation, the study was begun October 27, and will be continued for the period of approximately a year.

Assisted by personnel from the New Haven Department of Health, Mr. Hemeon will inspect all smoke producing equipment of industries and other large users of fuels as well as other possible sources of air pollution. On the basis of these tests and examinations, the foundation will advise municipal officials on the content of an ordinance for the abatement of air pollution.

In preparation for the proposed passing of a smoke-control ordinance in New Haven, the survey was ordered by Eric W. Mood, director of the city's Bureau of Environmental Sanitation and secretary of a special committee on air pollution.

Approval for the survey was passed by the New Haven board of aldermen when the city's board of health suggested that an organization experienced in the field of air pollution be employed to determine the extent and nature of the air pollution problem in that city.

An industrial city of 14,000 acres, New Haven has a population of 163,000. Its industries consist of the manufacture of guns, ammunition, hardware, clocks and rubber products.

(*More news on page* 118)

PRODUCT INFORMATION SERVICE

Use the postage-free postcards below for further information on:

- **News of Equipment and Materials**
- **New Catalogs**

Circle the Item Numbers in which you are interested and print clearly your name and address with title.

NEW CATALOGS

BUILDING INSULATION
A 6-page folder, B51-21, pointing out the benefits gained from using Fiberglas building insulations, is available from Owens-Corning Fiberglas Corp., Toledo, Ohio. Presented in easy-to-read style and in a size which makes it easy to carry in a pocket or purse, the illustrated folder explains why insulation is important, where it should be installed in a home and how one can get the most from his insulating materials. . . . . **Item 1**

DATA ON PIPE COILS
Catalog 26-B on pipe coils has been published by Acme Industries, Inc., Jackson, Mich. It covers various styles of coils, illustrating such types as spiral, rectangular, flat, oval and double coils. General specifications and bending data are furnished and a compact method of selection is also presented. Tables of heat transfer coefficients for pipe coils in both still air and water and circulating water and air complete the data given in the catalog. . . . . **Item 2**

REFRIGERATION EQUIPMENT
Catalog R-225, standard size, 48 pages, 2 colors, and entitled Kramer Refrigeration Equipment, has been published by Kramer Trenton Co., Trenton, N. J. Included in the catalog are descriptions, specifications and capacity data on the comprehensive line of air conditioning, coils, coolers, condensers, ice makers, unit coolers, water coolers, and Thermobank units made by the manufacturer. . . . . **Item 3**

PUMPS FOR AIR CONDITIONING
Package pumps engineered for a wide range of fractional horsepower applications, including air conditioning, in capacities to 80 gpm at heads to 100 feet, are described in bulletin 5287529 of Allis-Chalmers Mfg. Co., Milwaukee, Wis. . . . . **Item 4**

WATER POLLUTION RESEARCH
An 8-page booklet titled Research in Air and Water Pollution is available from New York University College of Engineering, New York, N. Y. It describes the work and facilities of the air and water pollution research section of the Research Division of the University and is well-illustrated with photos showing wind tunnel tests, balloon high-altitude experiments, radio-active laboratory, air sampling, and health techniques. . . . . **Item 5**

HOW TO ORDER VALVES
An 8-page booklet entitled How to Get What You Need When You Order a Valve is available from The Cooper Alloy Foundry Co., Hillside, N. J. It describes many of the peculiarities encountered in the relationship between companies and suppliers of the equipment they use, notably the lack of agreement on data to be disclosed in placing orders or bid invitations. Information necessary to enable the manufacturer, supply company or sales representative to fit the proper valve for the application at hand, is discussed in detail. This includes: Data required when ordering manually operated valves, power-operated valves, instrument operated valves, pressure and temperature regulators, traps and level controllers, relief valves and check valves. . . . . **Item 6**

FINNED PIPE FOR REFRIGERATION
Bulletins 555 and 560, each single sheet, have been issued by The Bush Manufacturing Co., West Hartford, Conn., and devoted to its line of finned pipe for refrigeration. This pipe is designed for heavy duty surface for brine and ammonia refrigerants. . . . . **Item 7**

PROCESS HEAT EXCHANGERS
Bulletin No. 120, 4 pages, has been issued by Niagara Blower Co., New York, N. Y. entitled Niagara Aero Heat Exchanger, devoted to this product which is used in metal working, process industries, and other applications for keeping fluids at a uniform temperature. . . . . **Item 8**

PLEASE SEND US MORE INFORMATION. Circle below item numbers on which you wish further information.

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OIL AND GAS BURNERS

Burners for Oil or Gas is the title of a 16-page brochure issued by Lammert & Mann Co., Chicago, Ill., and devoted to that company's line of burners for commercial and industrial boilers. **Item 9**

UNIT HEATERS AND CONVECTORS

A 4-page catalog, No. 29g, has been issued by Airtherm Mfg. Co., St. Louis, Mo., and describing and illustrating its line of steam unit heaters, convectors and direct fired heaters. Illustrative, dimensional and capacity data are accompanied by condensed text. . . . . **Item 10**

FREON HEAT EXCHANGERS

A two-color, 4-page catalog, No. 1313, describing a new line of heat exchangers, is available from Acme Industries, Inc., Jackson, Mich. The catalog supplies general specifications, dimensions and selection data. On the new units which are suitable for either Freon-12 or 22 and available in eleven models with capacities from 3 to 200 tons. With the new design, a gas to liquid side area ratio of 13 to 1 is now possible. The extremely low pressure drop of these units provide maximum gains for any desired super-heating effect. Curves are also furnished showing the super-heat performance, suction gas pressure drop and correction multiplier for the pressure drop. . . . . **Item 11**

CATALOG ON BOILER CONTROLS

A small-size circular, S-188, has been published by McDonnell & Miller, Inc., Chicago, Ill., to show its line of boiler water controls and safety devices. In eight compact pages it rounds up essential data on boiler water feeders and low water cut-offs for low pressure steam boilers, pump controls and cut-offs for higher pressure steam boilers, and pressure relief valves for use on hot water heating boilers and domestic hot water tanks and heaters. Product information includes illustrations, capacities and service recommendations. . . . . **Item 12**

COOLING TOWER CATALOG

An 8-page catalog on its water cooling towers has been issued by Water Cooling Equipment Co., St. Louis, Mo. The catalog describes various types of cooling towers, their selection, explains construction features for each and gives specifications and capacity data on each of the types made by the manufacturer. Included is a check list of 18 points of information required by the manufacturer when asked for an estimate. **Item 13**

CONTROLLERS FOR PROCESS WORK

A new bulletin, No. 1320, on Tag self-operated temperature and pressure controllers is available from Tagliabue Instruments Div., Weston Electrical Instrument Corp., Newark, N. J. These controllers have a wide variety of applications including use on hot water storage heaters, tanks, canning retorts, exhaust boxes, textile dryers, and scouring bowls. Control ranges vary from as low as 20 to 60 deg. F to as high as 255 to 300 deg. F. . . . . **Item 14**

NOISE ELIMINATION

Industrial noises and their control is the subject of a pamphlet issued by Industrial Acoustics Co., New York, N. Y. The pamphlet illustrates the principles of noise measurement and how these noises are related to the human ear. The types of industries that can profit from control of disturbing noises range from manufacturing and power plants to aviation factories and applies to such equipment as air conditioning systems; compressors; and so forth. . . . . **Item 15**

AIR HANDLING EQUIPMENT

A 16-page, condensed full-line catalog, Bulletin B-5164, in which equipment for air conditioning, air handling, and air cleaning is described in considerable detail, is issued by Sturtevant Div., Westinghouse Electric Corp., Hyde Park, Boston, Mass. Under air conditioning equipment are found unit air conditioners, unit heaters, home electronic air cleaners, hermetically sealed compressors, and condensers and water coolers. What the equipment consists of, its features, and its specifications are included. Air handling apparatus section includes ventilating equipment, air conditioning equipment, heating equipment, general purpose and industrial fans, and heavy duty and mechanical draft fans. Specications and capacity data are in considerable detail. The third section, on electronic air cleaning equipment section, includes the Precipitron, its principal of operation, home air cleaners, horizontal air cleaner, vertical air cleaner, and oil mist control unit. The how-it-works and how-to-use-it information is in usable form. . . . . **Item 16**

WATER COLUMNS AND GAGES

Bulletin WG-1811, 20 pages, describing its line of water columns and gages has been issued by Yarnall-Waring Co., Philadelphia, Pa. The different types of columns, alarms, and other products of this type are comprehensively described and illustrated. Important improvements have been made in the flat glass insert in the Yarway high pressure gages while the pressure sealed floating assembly design plus non-stick gaskets has been of help in solving service problems in high pressure boilers. A new type M illuminator with a mercury vapor lamp improves visibility in the boiler room. These features are described in bulletin. **Item 17**

Product Information Service

Use the postage-free postcards below for requesting further information on products mentioned in the following sections of this magazine:

News of Equipment and Materials • **New Catalogs**

Simply circle the numbers of the items in which you are interested. Please print your name and address.

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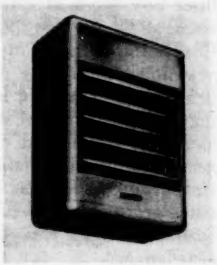
NEWS OF EQUIPMENT AND MATERIALS

Use the prepaid postcard opposite Page 108 for securing additional information on items described in this department.

Long Life Gas Unit Heaters

Development of a new line of gas-fired unit heaters with important new design features is announced by Modine Mfg. Co., Racine, Wis. A major reduction in weight and bulk, faster response to thermostatic control, balanced heating performance and lengthened service life are the advantages reported.



Heat exchanger and burners are stainless steel for resistance to rust and corrosive gases. Heat exchanger tubes are die-formed to provide their own individual combustion chambers. Each tube is individually fired for most effective and uniform transfer of heat from gas flame to heating surface. This method of firing, wherein the conventional combustion chamber has been eliminated, also makes it possible to heat all tubes evenly. By using stainless steel, the lag in tube warm-up is greatly reduced.

Elongated burner ports have approximately four times the free area of conventional drilled ports, greatly minimizing clogging and maintenance. Quick access to burner, manifold and pilot light is by hinged casing bottom which may be dropped by removing two wingscrews.

Illustrative of the light weight and small size is the average-sized Model 105 having an input of 105,000 Btu per hr. This unit weighs 106 pounds and is 30 inches high, 21¾ inches wide and 12½ inches deep.

The Units are offered in five sizes ranging from 65,000 to 165,000 Btu per hr. input. Bulletin 651 is available.

For more information, circle on Inquiry Card, **Item 18**

Condensate Return Units

A line of condensation return units, known as Motor-Mount, for returning condensate from steam coils, radiators, or steam operated equipment back to the boiler, is introduced by The Deming Co., Salem, Ohio. The centrifugal pumps have enclosed type bronze impeller and stainless steel shaft. The deep stuffing box has conventional packing rings for grease lubrication. Pump is mounted on the legs of the tank so no base is required.

The line includes single and duplex units. The former are designed for conditions involving occasional demands in excess of the capacity of a single unit, or where a stand-by pump is desired to assure continuous operation under all conditions.

Single units include pump, motor, storage tank, suction piping, Square-D float switch and water level gage, while duplex units include two pumps, two motors, one storage tank, one Square-D alternator switch and one water level gage. Capacities range from 2000 to 40,000 square feet of radiation.

For more information, circle on Inquiry Card, **Item 19**

Ups Concrete Heat Transfer

Heat-Crete, a densifier for concrete, has been introduced by Lee-Don, Inc., Harmarville, Pa. Purpose of the product is to increase the thermal conductivity and diffusivity of concrete in radiant heating installations.

In addition to increasing the thermal conductivity the material is said to increase the wearing qualities and increase the strength of the concrete. It also provides a glaze-like finish of concrete or other plastic masses.

The product is a blend of dry, granular ingredients packaged in bags weighing 40 or 80 lb. The smaller quantity is used for each cubic yard of concrete.

The maker claims that the thermal conductivity of the product is 21 as compared with values of between 6 and 7 for commercial grades of concrete with stone. The increasing of the conductivity decreases the amount of pipe required in the radiant heating installation.

For more information, circle on Inquiry Card, **Item 20**

Spray Cooler for Foods

An improved model No Frost spray cooler for refrigeration and refrigerated storage of products that are sensitive to the moisture content of the air, especially foods which are liable to dry out, shrink or discolor in cold dry air, is announced by Niagara Blower Co., New York, N. Y.

The equipment differs from previous models in that the air enters through the fans and is blown through the units. Air passes over refrigeration coils and through a spray of No Frost liquid solution which prevents the condensation of water and the formation of ice or frost on the coils. The chilled air, which may be as low as —20°F, passes direct from the spray chamber into the room, so that it contains no reheat from the energy of the fans and, therefore, higher humidity air is made available.

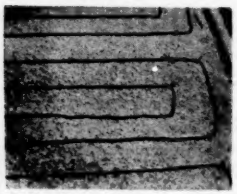
With no loss of cooling capacity from accumulation of frost on the refrigerating coils, no interruption for defrosting and no reheat added to the air, closer control of conditions is obtained with resulting improvement in the quality of products held in refrigerated storage.

For more information, circle on Inquiry Card, **Item 21**

Electric Cable for Heating

Thermwire, a flexible electric heating cable (top view) has been introduced to the industriial and consumer fields by Edwin L. Wiegand Co., Pittsburgh, Pa. The cable consists of a heavy-gage nickel-chromium resistor wire with tough abrasion-resistant insulating sheath.

The wire protects roofs, gutters, and downspouts from dangerous and costly accumulations of snow and ice; embedded in asphalt or concrete (lower view is during installation), it melts ice from home, shop, and office doorways, steps, sidewalks, driveways, or other pavements where severe and costly accidents occur; prevents freezing of pipes; heats soil for faster seed germination and plant growth; and provides an easy solution in many other circumstances where a portable, pliable, efficient heat source is required on-the-spot to cope with cold weather problems.



It is available through electrical dealers and distributors. It is made up in two packaged sets; one set is 80 feet long, 400 watts, 115 volts; the other is 160 feet, 800 watts, 230 volts. Each has a 10-foot cold lead section and plug. Thermostatic control is an optional feature.

For more information, circle on Inquiry Card, **Item 22**

2 New Suspended Oil Furnaces

Two new oil-burning suspended furnaces have been introduced by Norge Heat Div., Borg-Warner Corp., Detroit, Mich. They are the Model 100S, with a bonnet output of 100,000 Btu per hour and the Model 150S, with an output of 150,000 Btu per hour. Both feature a corrugated, plate-type heat exchanger of 12 gage steel.

A pressure-atomizing burner is flange mounted and fired into a horizontal, round combustion chamber. Tunnel firing provides efficient combustion of the fuel. Heating surface area is exceptionally large. Filter frames and access panels to the blower assembly are located on the four sides and ends of the units.

The furnaces are equipped with four eye bolts welded to a strong internal frame for rigid suspension.

For more information, circle on Inquiry Card, **Item 23**

Commercial Type Deodorizer

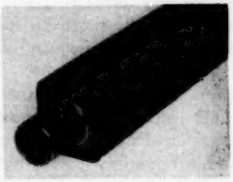
A new commercial deodorizer and evaporator have been formulated specifically for large-scale problems by Boyle-Midway, Inc., New York, N. Y. The deodorizer, named Renovair, is a liquid product which neutralizes odors as it evaporates into the surrounding air. It uses non-toxic elements, contains no perfume to mask odors, nor does it contain formaldehyde or chlorophyll.

The Renovair Gyrostatic evaporator, designed for introducing the liquid into any air conditioning system or unit, is small and compact for easy and economical installation. The evaporator is powered by the flow of air through the unit. The deodorizer can be applied to all types of commercial, institutional, industrial and processing plants. For use in non-air conditioned spaces, such as in washrooms, other types of dispensers are available.

For more information, circle on Inquiry Card, **Item 24**

Finned Surface Line Expanded

Airfoil finned radiation is the trade name adopted for three new types of extended surface heating units announced by Radiant-Ray Radiation, Inc., New Britain, Conn. Introduction of the new units extends the company's line to include heating units for industrial, commercial, institutional and general utility installations. Heretofore, the line has consisted primarily of baseboard heating units for household installations.



Designed for use with hot water heating installations or steam heating systems, the new units have a finned heating element which assures maximum heat transfer and convection of the air which passes between the fins.

The three types now available are: AFR-1 which consists of 1 inch copper tubing with 3¼ x 3¼ inch aluminum fins; AFR-2 with 1¼ inch standard steel pipe with 3 x 4 inch steel fins; AFR-3 consisting of 2 inch standard steel pipe fitted with 4 x 4 inch steel fins. All types have 3 inch extensions on each end and may be used singly or in tiered installations.

For more information, circle on Inquiry Card, **Item 25**

300 Lb. Hazardous Liquid Union

A 300 lb steam pipe union, made from seamless and forged steel, is now available from The Capitol Mfg. & Supply Co., Columbus, Ohio. This union is listed by Underwriters' Laboratories for use with all piping applications, including hazardous liquids, and 2000 lb cold water, oil, or gas, non-shock.

This union supplements the maker's 250 lb union and, in black, is impregnated with an effective rust resistant. The unions are also supplied zinc coated. All unions are furnished with a brass to steel ground joint seat and, for modern merchandising, are cartoned in convenient quantities at no extra charge.

Due to improved production techniques, the unions are low in price. At the present time, these unions are being manufactured in sizes from ½ to 2 inches, incl.

For more information, circle on Inquiry Card, **Item 26**

Heating, Ventilating Units

Heating and ventilating units for heating and filtering recirculated air, fresh air, a mixture of both, or for ventilation only, are announced by Kennard Corp., St. Louis Mo. These ruggedly constructed and easily installed units, conventionally used for heating large spaces or as a central station unit to heat many small rooms, can also be utilized for a variety of special and process applications.

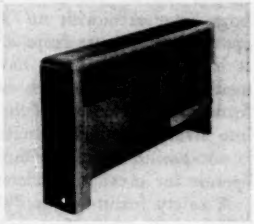
The units will handle air volumes from 400 to 21,000 cfm, and are available for wall, floor, or ceiling mountings. The preheat and reheat coils have a face area of 1.1 to 32.5 sq. ft. Tip speeds and outlet velocities are moderate.

Optional equipment available includes mixing box and dampers, face and bypass dampers, throwaway, cleanable or high velocity filters, and target, grid or pan humidifiers.

For more information, circle on Inquiry Card, **Item 27**

Non-Ferrous Convector Line

As a further expansion of its line of heating equipment, Bush Mfg. Co., West Hartford, Conn., has announced a complete line of convectors.



Heating elements are constructed of copper tubes and headers and aluminum fins. The cabinets are of heavy gage steel and are provided with removable front panels. Outlet grilles direct air flow away from the wall. All cases are finished with a prime coat of paint. Lengths vary from 16 to 64 inches and depths from 4 to 10 inches with either 20, 24 or 32 inch heights.

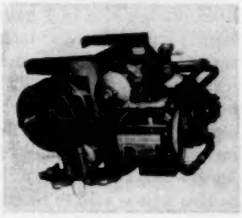
Bulletin 545 is available.

For more information, circle on Inquiry Card, **Item 28**

Home Size Heat Pump

A heat pump for year-round air conditioning for the home has been developed by Acme Industries, Inc., Jackson, Mich.

The units are placed in either the basement or utility room with pipes leading outside. Air is drawn in and heat absorbed from the air through the evaporation of Freon. When the refrigerant vapor is compressed, it releases heat which is circulated through the house.



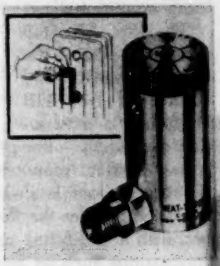
For summer operation, the cycle is reversed, by a completely automative valve. The electrically-powered Flow-Temp heat pump then takes heat and moisture out of the inside air and discharges it outdoors.

The chief advantage to the home-owner is the year-round air conditioning that is produced. In addition, there is no soot, grime or dust from combustion. The maker is producing several sizes of heat pumps from 2 to 15 hp capacity.

For more information, circle on Inquiry Card, **Item 29**

Adjustable Radiator Air Valve

Room temperatures are individually and automatically controlled through the use of an improved thermostatic radiator valve. As illustrated, simple dial setting results in any wanted room temperature. The valve is made by Heat-Timer Corp., New York, N. Y.



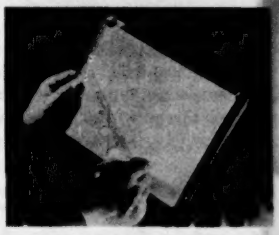
These radiator valves, through automatic control or radiator air venting, allow desired temperature variations from room to room.

The valves are applicable to any low pressure one-pipe steam system without interference or alteration with existing boiler controls. Redesigned for economy without loss of efficiency, the valves retail at $3.95. The temperature-sensitive phosphor bronze bellows and other features remain the same as in the former model. Body of valve is brass, finish is chrome.

For more information, circle on Inquiry Card, **Item 30**

Portable Plastic Drawing Board

A portable drawing board, the Graphostat, molded from lightweight Bakelite styrene plastic is available from A. Partrick Co., Westwood, N. J. The drawing board consists of a single molded piece of clear plastic, 9¾ x 12¼ inches. Four corner clamps for attaching 8½ x 11 inch paper make it no longer necessary to carry thumb tacks. The clamps are cleverly recessed into the plastic so that the triangle or roller can ride freely over them without interference.



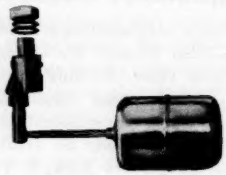
Two metal straight edges, one vertical and one horizontal, are retractable so that the triangles can be moved over all four edges of the paper. The use of plastic has reduced the weight of the drawing board by as much as 75% over conventional boards. The board is easy to carry and is space-saving for it can easily be accommodated in a brief case. Thirty, sixty and forty-five degree triangles can be stored in recesses underneath the drawing board and can be clamped securely in place. Price, $3.95 postpaid.

For more information, circle on Inquiry Card, **Item 31**

Float Valve Has Many Uses

A new float-operated valve has been announced by McDonnell & Miller, Inc., Chicago, Ill. It provides large capacity for a valve of such compact size, and combines non-corrosive construction with simplicity of design and operation. Three variations of the valve are available in the series, the No. 18, No. 118 and No. 518, which adapt it for a wide variety of operating conditions.

No. 18



No. 118

The No. 18 (top view) consists of the valve mechanism and float. The No. 118 (bottom) is a variation designed to offer protection against back-siphonage; it has the float mounted at right angles to the valve so the valve proper is always far above the water level. The No. 518 includes the float and valve in a die-cast chamber, with a well-fitting cover, and is designed for external applications such as on humidifiers.

The valve mechanism itself consists of only a few parts. Except for the neoprene valve seat, all parts are of copper or brass. The valve opens to full capacity with only small float drop, and closes tightly against supply pressures up to 100 lb. The entire assembly is held together by a single brass pin, so that it can be disassembled easily for inspection or cleaning.

The No. 18 valve can be used on humidifiers of warm air furnaces and evaporative coolers in air conditioning equipment on wet and dry bulb hygrometers. It is also serving to add water to radiators of stationary engines; on coffee urns and beverage dispensers; and on proof boxes in bakeries. Some of its many other installations include fish aquaria, bird bath fountains and steam baths.

The capacity of the No. 18 Series Float Valve ranges up to almost 1500 gph, depending on supply pressure. For mounting the valve, water supply connection has a 5/8 inch thread with matching nut and washers. For actual water supply line this same connection has a 1/8 inch pipe tap.

For more information, circle on Inquiry Card, **Item 32**

Heating Elements for Urns

Addition of three new urn heating elements to its line of Thermalink tubular electric immersion units is announced by Electro-Therm, Inc., Silver Spring, Md. The new elements are designed for use in coffee urns, steam tables, sterilizers, and other equipment requiring water-heating elements for base insertion.

Two of the new elements are of conventional size for installing in 2 7/16 inch diameter holes, and both types have two separate seamless copper elements interlocked on the mounting header for three-heat operation. They are available in standard wattages from 1000 to 6000, and have conservative watt density ratings to assure long service life. The two types are interchangeable and are identical in every respect except for method of mounting.

The Type UHT has the conventional straight thread mount with locknut, while the Type UHF has an exclusive new flange-type mount with take-up plate which cuts installation time to a fraction of that formerly required. The new mount is also easier to install since it is assembled with small Allen wrench instead of the usual large, wide mouth wrench.

The third element, Type UHFJ, is a smaller flange-mount unit requiring only a 1 3/8 inch hole for mounting. It is similar in design to the Type UHF element but consists of one copper heating element for single-heat operation. Standard models include wattages from 600 to 1500. Bulletin 111 is available.

For more information, circle on Inquiry Card, **Item 33**

High Velocity Metal Filter

Announcement is made of a new high velocity air filter, the Airsan Viro-Crimp, by Air Filter Corp., Milwaukee, Wis. It will operate at face velocities of 300 to 500 ft per min at minimum resistance and high efficiency.

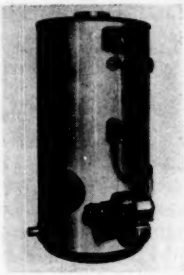
The filter core (illustrated) is of the viscous type, constructed of horizontal layers of galvanized wire mesh so arranged as to assure a large filter area with no appreciable pressure drop. It is so arranged as to have no direct opening in the media, assuring efficiency, dust holding capacity and uniform loading. Because of the crimp feature, the air flows into divided channels being baffled by a filter wall. There is no specific velocity within its range at which it must operate for maximum efficiency.

A safety feature is that the edges are hemmed, providing a smooth surface and allowing easy handling for servicing. The filters are easily cleanable. Drain slots are provided to hasten drying and aid in cleaning.

For more information, circle on Inquiry Card, **Item 34**

Large Oil-Fired Water Heater

A large oil fired water heater, Model 130E, has been added to the line of oil fired water heaters made by Bock Corp., Madison, Wis. The unit has a storage capacity of 100 gallons and can raise 550 gallons 80 degrees per hour. Firing rate is 3 gallons per hour. Physical data include 54 square feet of heating surface, an outside diameter of 32 inches, height of 65 inches, 9 inch smoke pipe, 2 inch water connection. The burner will use Numbers 1, 2, or 3 oil.



This unit is said to be sufficient to handle an apartment building with 12 to 24 units.

For more information, circle on Inquiry Card, **Item 35**

Low Pressure Switch for Gas

An inexpensive diaphragm switch, known as the L-38 low pressure switch, is now available from General Controls Co., Los Angeles, Calif.

This control, a unit with many uses, contains a normally open, or normally closed switch actuated by gas pressure and applicable to heating plant installations where it is necessary to operate a switch by a variation in gas pressure.

Operation of the control is simple and effective. Pressure applied against a spring-loaded diaphragm operates to tilt a mercury tube switch. The diaphragm is made of material impervious to all types of gases, including liquefied petroleum gas, and the spring loading mechanism may be easily adjusted by a set screw located at the accessible top cover plate.

The control also features a built-in level in the top cover which makes proper installation possible with a minimum of effort.

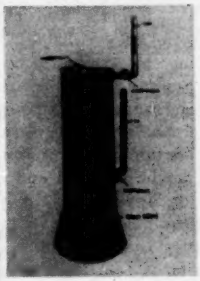
The L-38 is suitable for air or gas applications only, at rated pressures. Installed between an automatic gas valve and a gas burner, for instance, the control insures instantaneous switch operation for a blower or pump motor on heating equipment. It can also be used as a device to turn on signal lights where gas or air pressure fails.

The operating point is adjustable over a pressure range of 3 to 12 inches of water and operates from pressure differential of 2 to 4 inches of water.

For more information, circle on Inquiry Card, **Item 36**

Drier for Air and Gases

The Vi-Speed compressed air drier and filter has been introduced by Van Products Co., Erie, Pa. This device is said to remove in an efficient manner from compressed air and gases, the entrained moisture, oil, dust, dirt and scale, and reduces the humidity below the condensation point and acts as a storage tank.



The drier comes in two sizes, Model 25 delivers 25 cfm, Model 200 delivers 200 cfm of air at 100 lb per square inch. The filter material is Dryolite, which is said to be quite inexpensive and, being soluble, never needs processing.

Applications include those in compressed air lines and in the drying of tanks in chemical and paint factories, breweries, and so on; piping systems, refrigerating coils and in the drying of gases and liquids. It is also used in liquid agitation and displacement whereever dry, clean air is needed.

The upper section of the tank contains a system of heavy screens which position the soluble, non-corrosive filter nuggets. This filter material allows gases to pass through it readily, attracts, and is soluble in water. The solution so created also attracts a great deal of moisture and flows downward, wetting and cleaning baffles which provide large contact areas to reduce the moisture. The counterflowing solution is then atomized by the incoming air, and the mist so created washes air and absorbs moisture. Heavy particles of solids and liquids are removed in the lowest section of the drier by centrifugal force.

For more information, circle on Inquiry Card, **Item 37**

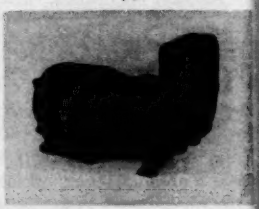
Oil, Abrasion Resistant Hose

A new, multi-purpose, industrial-type hose, known as Abrasoflex, both oil- and abrasion-resistant, is announced by Mercer Rubber Corp., 66 Reade Street, New York, N. Y. It can be used for any of eight industrial applications including air, welding, cold water, hot water, paint spraying, oil spraying, grease and gasoline. It is available with a black cover, with 1- or 2-braid, high-tensile reinforcement in seven sizes ranging from 3/16 to 1 inch inside diameter, suitable for 250 lb pressures.

For more information, circle on Inquiry Card, **Item 38**

Self-Priming Motor Pumps

A new line of self-priming Motorpumps has been developed by Ingersoll-Rand Co., Phillipsburg, N. J. They are intended for pumping applications under suction lift where the presence of air or vapor makes it impractical to use the conventional centrifugal pumps. The pumps are used in process and bulk station applications, for drainage, bilge pumping, sump draining and irrigation service.



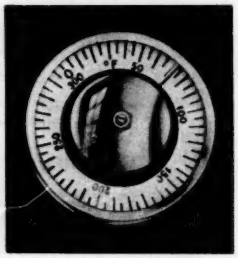
Conventional centrifugal pumps are unable to eliminate appreciable volumes of air or vapor when operating under suction lift and completely lose prime when such vapor is present. To reestablish prime, it becomes necessary to fill the suction line and casing before starting.

The new pump overcomes this disadvantage by means of recirculating liquid trapped in the casing. The pump impeller discharges through two passages into a discharge chamber. During priming the upper passage discharges a mixture of vapor and liquid into the discharge chamber. Here the vapor separates from the liquid and passes out the discharge pipe. The remaining liquid reenters the impeller through the lower passage to mix with more vapor drawn in from the suction pipe and is separated from the liquid in the same manner. When the suction pipe is finally filled with liquid and the pump is primed, flow through the lower passage reverses and both passages act as normal pump discharges. During normal pump operation there are no recirculation losses and thus no need of valves to cut off recirculation. No flap valve is used because the pump casing is so proportioned that sufficient liquid is trapped on shut down to insure priming when the unit is re-started.

For more information, circle on Inquiry Card, **Item 39**

Measures Surface Temperatures

A surface temperature thermometer, Model 310, for the fast and accurate checking of the outside temperature of pipes or the inside surface temperature of walls, ceilings and floors, has been developed by Pacific Transducer Co., Los Angeles, Calif. The instrument may be quickly and easily fixed to any flat surface by applying a small amount of silicone grease, which is supplied with the instrument, and sticking the thermometer in place. This silicone grease does not melt and so holds the instrument throughout all ranges of temperature.

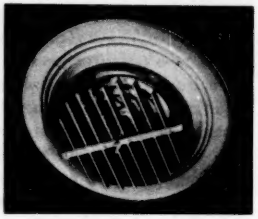


Also furnished with the thermometer is a small magnetic clamp which will hold it securely in place when applying it on steel dies or other ferrous surfaces. The thermometer may be placed on pipes carrying heated or cooled liquid by affixing it in place by either the magnetic clamp or the silicone grease. The thermometer has been designed to produce an essentially unilateral thermal instrument which indicates the temperature from the back of the instrument only. A highly reflective evaporated mirror on the dial insures the thermal element against external radiation. The range is 0 to 300 deg. F calibrated in 2 deg. increments. The thermometer is 2 inches in diameter, weighs one ounce, and net price is $4.95.

For more information, circle on Inquiry Card, **Item 40**

Diffuser Has Adjustable Area

An air diffuser which has the unique property of having an infinitely variable effective area, the Flexiflo, has been introduced by Universal Diffuser Corp., New York, N. Y. It consists of two main parts: an outside spun aluminum cone, which acts as a finishing ring, and a diffuser proper, consisting of a conical spiral in which the continuous blades are elastically held together with radial spokes.



The spiral is centrally connected to a cross bar by a threaded rod. By turning this rod, the blades can be shifted to any position, up or down, from closed to wide open, thus providing adjustment of the effective area. Moreover, the blades are so designed that, no matter what the percentage of opening, and the change in volume, the air pattern will always remain constant. The unit creates a large number of tip jets which produce a violent aspirating and a rapid mixing effect, resulting in a large entrainment of room air. This rapid mixture of room and cold air creates the acceptable final temperature in a very short space of time or, in other words, this final temperature is reached near to the diffuser.

Another feature is the equalizing deflector. The deflector vanes, independently movable, are attached to the main cross bar and can be adjusted to any position from the outside. This provides the installation man with a means of adjustment after the diffuser has been set in place. The unit and the deflector vanes can be rotated to any angle after installation. Vane rotation provides a means of compensating for unequal distribution of air in the supply duct and for blocking off air in the direction of a nearby obstruction such as a column or beam.

For more information, circle in Inquiry Card, **Item 41**

Convector for Year-Round Use

The Flow-Temp convector has been announced by Acme Industries, Inc., Jackson, Mich. This newly designed product is intended for use with Flow-Cold systems for summer air conditioning, or to be used with heat pump systems for year-round air conditioning. It is also adaptable with boiler systems for this latter use.

The chief advantage of the convector is that it has only one basic assembly for all types of installations. The same basic unit can be wall-mounted, wall-recessed, semi-recessed, ceiling suspended or floor-mounted. Dealers do not have to carry an extensive inventory of convectors in all models and for all uses.

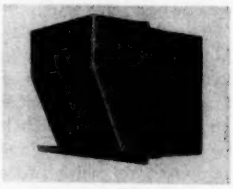
The units are quiet, having over-sized slow speed blowers and spun glass insulation. Every room has individual controls (three speeds) with a constant supply of clean air. It requires only simple electrical and water connections adaptable for right- or left-hand connections.

Three basic models are available. All units are 10⅝ inches in depth, 24 inches high. Cooling capacities with 46° water *on* at medium speed are, for the CV-7, 7,200 Btu per hour; CV-12 provides 12,000 Btu per hour and the CV-18 furnishes 18,000 hourly Btu. Capacity for heating at 180° water *on* at medium speed is CV-7, 15,700 Btu, CV-12, 26,000 Btu, and CV-18, 39,000 Btu per hour. Catalog FC-210 is available.

For more information, circle on Inquiry Card, **Item 42**

Easy-to-Install Cooler Walk-Ins

Development of an easily-installed package refrigeration unit for walk-in coolers is announced by Kool-Rite Co., Roberts, Wis. The unit is designed for use with all types of perishables, including meats, dairy products, produce, beverages, floral merchandise and poultry.



Each unit, an entirely self-contained refrigeration plant, can be installed and operating in approximately one-tenth the time required by conventional systems, the maker reports. When installation is complete, immediate refrigeration is obtained by plugging in to a standard electrical outlet. There are no valves to open or close when placing the unit in operation.

Units are shipped as a single package, eliminating excessive handling and transportation costs. Five sizes, ¼, ⅓, ½, ¾ and 1 hp units, insure a wide range.

(*Concluded on page* 116)

For more information, circle on Inquiry Card, **Item 43**

Another Case of COPPER WHERE IT COUNTS

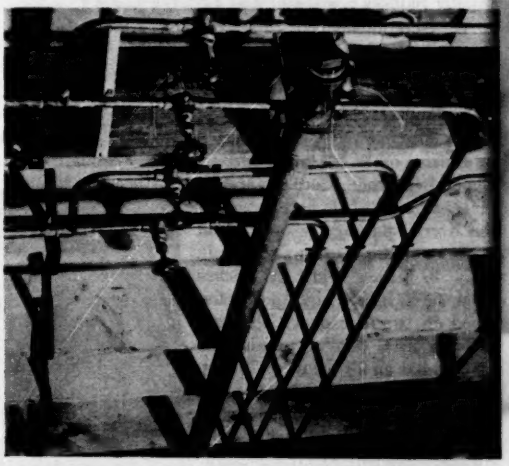
MOHAWK GARDENS, ROME N. Y.

THE very scarcity of copper has served to point up the many merits of this metal better than anything we might say about it. For, when architects, builders and contractors have tried to find a substitute, they soon discovered many places in building construction where there just isn't any substitute. And they don't hesitate to tell us so.

Two mighty important copper spots are the heating and plumbing lines. That's why Revere Copper Water Tube was used for the entire heating system and for the hot and cold water lines in the plumbing system at Mohawk Gardens . . . the owners were building for permanency.

Although quantities are necessarily limited you can still use Revere Copper Water Tube for domestic hot and cold water lines, underground service lines, industrial processing and for gas equipment.

See your Revere Distributor. He will advise you of the availability of materials and, in the event you wish to discuss your technical problems, put you in touch with Revere's Technical Advisory Service.



NO WIDE OPEN SPACES are needed for wrench swinging when Revere Copper Water Tube is used. It is easily joined with solder or compression fittings, and requires fewer of these fittings because it is easily bent and comes in 60'-length, soft-temper coils. It also is available in hard and soft tempers in straight lengths. Note how neat an installation is made possible with Revere Copper Water Tube, too. Shown is part of the 31,000' of Revere Copper Tube used for heating and the 24,240' used for plumbing in Mohawk Gardens, Rome, N. Y. Architect, Harold G. Rice; Plumbing and Heating Contractor, O'Shea Supply Company; Builder, A. H. Pearsall, Inc. . . . all of Rome, N. Y. Revere Copper also was used to flash the roofs and windows, as well as for the gutters and downspouts.

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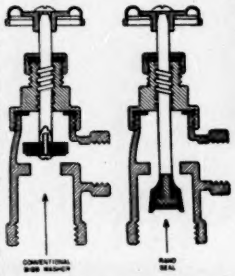
Valve Seal Is Leak-Proof

An innovation in valve design, the Rand Seal, is announced by Rodic Chemical and Rubber Corp., New Brunswick, N. J. This seal makes possible a valve that is leak-proof, long wearing, easy operating and comparatively inexpensive to manufacture.



Essential operation of the seal is based on working with, rather than against, the fluid flow. The cone-shaped seal is closed in the same direction as the movement of the liquid, allowing high or low pressures to seal the valve. Leak-inducing permanent deformation found in previous designs based on the compression of a resilient member against a non-resilient seat is thereby eliminated.

The cup-shaped conical washer of the seal incorporates an imbedded metal plug which eliminates bending and warping and makes the seal leak-proof. If contaminants in the fluid, such as sand or grit, are not pushed ahead of one sealing line contact, the conical shape of the seal provides establishment of a new line contact without damage to the bore. The rubber member of the seal is specially compounded to withstand oil, grease, steam, water, and most industrial chemicals.

Adaptable to many present designs of valves and other devices for the control of fluid and gas flow, the seal, usually reduces machining and material costs.

For more information, circle on Inquiry Card, **Item 44**

7½ Ton Conditioning Unit

A compact 7½ ton capacity self-contained air conditioner for cooling spaces such as average size retail stores or general office has been introduced by Frigidaire Div., General Motors Corp., Dayton, Ohio. In spite of its high capacity, the overall package is only about as large as the average 5 ton unit. It is 40 inches wide, 28 inches deep, 86⅜ inches high and is finished in two-tone gray. The unit delivers 2700 cfm of conditioned air and has an air throw of 75 feet.

Installation and operation of the unit is simple. The complete mechanism is located within the compact cabinet. Electrical, water and drain connections are all that are necessary. The simple controls are located behind a small access panel on the front of the cabinet. A simple *On—Off* switch allows the user to manually control the unit, but the unit is designed to provide fully automatic room temperatures by a control knob which is set for the temperature desired.

The unit can be installed remotely with ductwork if desired. In this way it can furnish air for several different individual rooms. Outside air can be brought into the unit by the installation of a low resistance duct connected to a grilled opening in the rear of the cabinet. A two-row steam heat coil for heating purposes is available as accessory equipment.

For more information, circle on Inquiry Card, **Item 45**

Locates Noise in Pipe Lines

The problem of locating friction noises in bearings, pistons, gears, ratchets, cams, clutches, traps, pipe lines, valves and other mechanisms is answered by a new, portable electronic instrument introduced by Anco Instrument Division, Chicago, Ill.

Known as the Elec-Detec, this electronic stethoscope employs a metal probe which serves as a microphone transmitting impulses electrically to headphones. It localizes the source of tell-tale noise, helps diagnose the trouble and determine quickly where to make repairs without tearing down the entire equipment, it is stated.

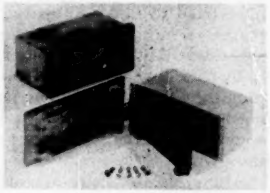
According to the manufacturer, the electric amplifier and the sensitivity control on the instrument make it possible to detect sounds at low speed that otherwise could be heard only at high speeds. Even the tick of a fine watch and sounds that are not normally audible are clearly defined through this instrument, it is said, while air-borne sounds do not register.

The device is furnished complete with high impedance type headphones, batteries, and leather carrying case.

For more information, circle on Inquiry Card, **Item 46**

Radiant Glass Panel Control

The Mulvany Radiantrol thermostat, designed specifically for use with radiant glass heating systems is being distributed by Continental Radiant Glass Heating Corp., New York, N. Y. The thermostat is a line-voltage unit requiring neither relays nor transformers.



The device controls comfort conditions in the heated space through the differential expansion between its sensitive aluminum front plate and invar control bars mounted between the ends of the front plate. Any decrease in ambient heat conditions cools the sensitive front plate and causes it to contract. This contraction bows the invar control bars slightly so as to lower the contact lever. As the contact lever nears the On position, the permanent magnet pulls the lever down in a smooth motion, closing the silver contacts, and allowing energy to flow to the glass panels. When the room temperature rises to set conditions, the sensitive front plate is warmed and expands so as to straighten slightly the control bars and raise the contact lever to break the contacts.

The thermostat is made in two sizes, Model 3W and 5W, the former being for the control of not more than two 1,000 watt glass panels, the larger for not more than four 1,000 watt glass panels. Each comfort zone should be controlled by its own thermostat on the inside wall.

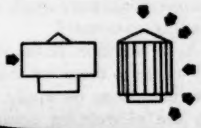
For more information, circle on Inquiry Card, **Item 47**

do you know

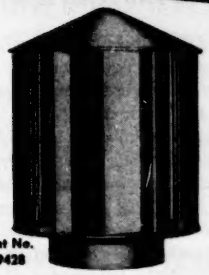
the TRUTH about ventilators?

Ventilators are usually selected on the basis of their *capacity ratings.* That makes sense, but do you know that:

1. Capacity ratings of most ventilators are *not* certified.
2. Capacity ratings of most ventilators are based on *horizontal* wind tests only.



Breidert Air-X-Hausters
provide safe, sure ventilation no matter which way the wind blows!



Patent No. 2269428

and . . . Breidert Air-X-Hausters are the *only* ventilators with published certified capacity ratings based on tests* made with wind blowing in *all* directions as shown above.

Only such tests can guarantee the capacities a ventilator will deliver under actual operating conditions. No matter which way the wind blows, barring interior negative pressures, the Breidert provides safe, sure ventilation . . . on roofs, vent flues, chimney tops. Stationary, no moving parts, nothing to jam or get out of order.

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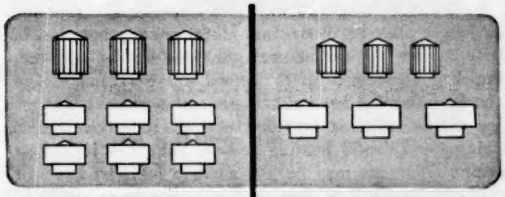

It takes fewer Breiderts to do the job as same size conventional ventilators. (or) *You can use the same number of smaller size Breiderts to do the same job as conventional ventilators.*

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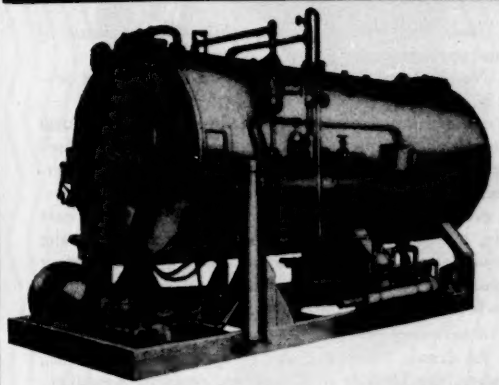

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• AUTOMATIC

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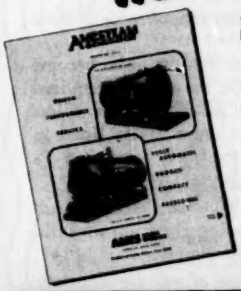

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NATURAL GAS SLOWDOWN

clarified by Petroleum Administration's answers to questionnaire on restraining order.

A series of questions and answers explaining and clarifying the PAD Order No. 2, which slows down extension of natural gas service, has been released by the Petroleum Administration for Defense. Selected questions from this series follow:

Q. Does PAD Order No. 2 prohibit all expansion of natural gas service?

A. No. It slows down the expansion but does not prohibit it.

In communities recently converted to the use of natural gas, a reasonable space heating expansion, as determined by reviews of past growth of natural gas utilities is permitted.

In even the most critical of areas where gas is in short supply, a seller can add during the 12 months from the effective date of the order, August 15, new space heating customers up to 1% of all the customers of any kind he had when the order was issued.

Q. Where is the order now effective?

A. As drawn, the order was to apply in Connecticut, Delaware, the District of Columbia, parts of Kentucky, Maryland, Massachusetts, Michigan, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Virginia, parts of West Virginia, and Wisconsin.

Section 704 of the Defense Production Act, however, provides that no order which restricts the use of natural gas issued by the Petroleum Administration for Defense will be effective in "any State in which a public regulatory agency has authority to restrict the use of natural gas and certifies to the President that it is exercising that authority to the extent necessary to accomplish the objectives of this Act."

Six States have sent certificates to the President—Maryland, New Hampshire, Ohio, Virginia, West Virginia, and Wisconsin. Consequently, the restrictions of the order are not applicable in these States.

Q. Is PAD Order No. 2 completely inapplicable in these States that have certified?

A. No. The provisions of Section 3 of the order become inapplicable after certification. But the reports required by Sec. 6 (d) must be made by all natural gas sellers operating in these States and the other States listed in Schedule B of the order.

Q. What is the purpose of these reports?

A. The reports are designed to give the Petroleum Administration for Defense a continuing check on areas in which natural gas may be in short supply.

Q. Does the order affect the use of gas for domestic cooking, heating water or refrigeration?

A. It does not. The order applies only to the use of gas for space heating or for large volume use.

Q. Does the order restrict the delivery of natural gas for use as a raw material in a chemical process or as a source of the heavier hydro-carbons?

A. No. The restrictions on deliveries to large volume consumers cover only gas that is to be used as a fuel.

Q. Does PAD Order No. 2 require any natural gas seller to deliver gas to a new customer or to increase supplies to an old customer?

A. No. The order does not require that any deliveries of gas be made. It merely prohibits certain deliveries, thus to a degree overturning the obligation that a public utility must supply service to anyone who requests it.

Q. Is space-heating equipment designed to heat more than one room in a home covered by the definition of "central space-heating equipment"?

A. Yes. The definition covers any piece of equipment intended to heat two or more rooms, and also separate radiant fires that heat two or more rooms in a house.

Q. Does the restriction on delivery of gas to large volume consumers apply to an increase in delivery to an existing customer?

A. It depends. If the customer is going to increase his use of gas to the point that he must install new equipment, the limitations do apply. If he is going only to increase his use of existing equipment, the restriction does not apply.

Q. Suppose a prospective industrial customer has standby facilities for manufacturing gas himself in sufficient volume and of a high enough heat content to replace the entire prospective delivery to him. Would the seller have to obtain authorization from PAD before supplying such a customer?

A. Yes, unless the delivery falls within the exceptions.

When the order speaks of standby equipment for the manufacture of gas, it has in view the use of such equipment by the seller of the gas, not the user.

Q. Under the order a community with more than 5,000 gas customers that has just recently been converted from manufactured gas service to natural gas may attach space-heating customers at a rate of 5% of the total number of customers in the community on the date of conversion. Is this 5% in addition to the exemptions specified in the subparagraphs (i), (ii), (iii), (iv), (v) and (vi) of Sec. 3 (b)?

A. The 5% is the total expansion that may be permitted in each year in such a community.

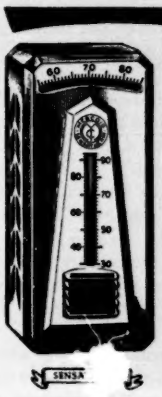
Q. Does a firm oral commitment made prior to August 22, 1951, by a natural gas seller to deliver natural gas for the operation of central space-heating equipment during the 1951-52 heating season satisfy the requirements of subparagraph (v) of Sec. 3 (b)?

A. No. Subparagraph (v) states specifically that the agreement must be in writing. However, any notation in writing made by the natural gas seller in the ordinary course of business prior to August 22, 1951, evidencing acceptance by the natural gas seller of a request for service, will be sufficient, provided service is to be commenced during the 1951-52 heating season. Inquiries regarding specific situations may be presented to PAD by letter or otherwise, and will be answered as promptly as possible.

Q. When can applications be made by sellers for exemptions from or modifications of the order under Sec. 5?

A. At any time. But the filing of such an application does not stay the effect of the restrictions unless notice of intention to file was given to PAD on or before August 22, 1951, and the application itself was filed before September 15, 1951.

• The Air-Maze Corp., Cleveland, Ohio, has purchased the Detroit Air Filter Co. of Woodstock, Illinois. Manufacture of Detroit, Arco and Dustay throwaway type filters will be continued at Woodstock.



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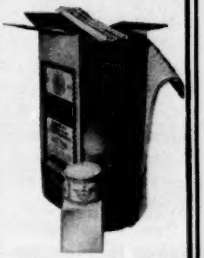

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Grant Wilson inc.

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SUN'S HEAT

used to warm farm buildings, take out surplus moisture, engineers told.

Recent developments in farm building planning makes it possible to use the sun's energy in winter for additional warmth in animal shelters, members of the Pacific Northwest section of the American Society of Agricultural Engineers were told at a meeting in Moscow, Idaho.

Heat potential from the winter sun may be as much as 200 Btu per (hr) (sq ft) of glass area on a clear day in January in the northern part of the country, according to W. Everett Eakin, director of farm research for Libbey-Owens-Ford Glass Company, who spoke on proper farm building window planning.

• **CONSTRUCTION.**—To take advantage of this warmth from the winter sun, farm buildings should be well insulated, have proper ventilation and be planned with large areas of double-pane, insulating glass facing directly south, Mr. Eakin said. Roof overhangs may be provided to shut out completely the rays of the summer sun when buildings should be kept cooler.

Application of a special grade of Thermopane to farm buildings has made practical the adoption of the solar principle of heat to farm buildings. A type made from two lights of polished plate glass with a sealed pocket of dry air for insulation has been used in residential and commercial buildings for more than a decade. Recently, Thermopane has been made available in standard sizes for farm buildings in a more economical heavy sheet glass, rather than plateglass.

• **MOISTURE.**—Energy of the sun in addition to providing warmth for the comfort of livestock or poultry can also be used in taking surplus moisture out of the building, the agricultural engineers were advised. Since warmer air will carry more moisture than cold, the added warmth increases the efficiency of the ventilating system in reducing relative humidity within the building.

• **EXAMPLES.**—One solar-type milk house built in Pennsylvania a year ago with an electric heating cable in the floor for emergency use never got cold enough on the inside to activate the heating cable although outside temperatures went as much as 15 to 20 degrees below zero, Mr. Eakin told the agricultural engineers. In a central farrowing house in Iowa using large insulating windows in the south wall, the inside temperature never dropped below freezing although the outside temperature hit 25 to 30 degrees below zero. The only artificial heat in the building was provided by heat lamps in the brooders for the little pigs.

New solar-type animal shelters at the University of Minnesota, Michigan State and Pennsylvania State College will make possible additional studies on the use of solar energy in livestock buildings, the speaker said. Further research is needed to determine the period the window overhang should shut out the summer sun, he pointed out.

To better understand how larger areas of insulating glass help to take advantage of the solar heat principle, Mr. Eakin explained to the engineers that the sun's infrared rays pass through the glass on a short-wave length. The rays strike and warm the interior surfaces and are then re-radiated on a longer wave length which will not pass out through the glass.

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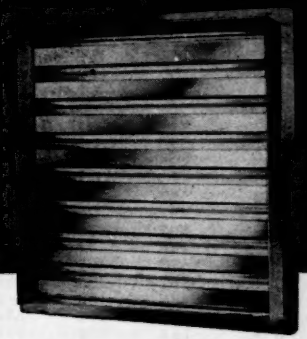

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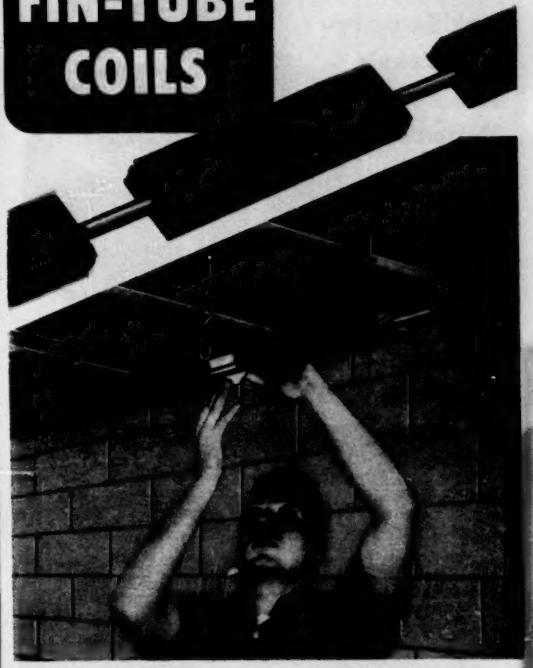

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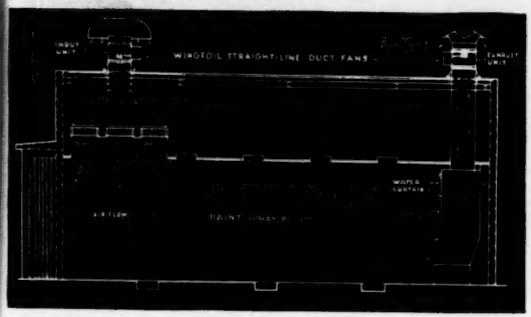

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DEGREE-DAYS FOR OCTOBER, 1951

(A) Airport readings; (C) City office readings; (O) Readings at a point on outskirts of city.

HEATING AND VENTILATING'S 24th Year of Publication of Monthly Degree-Day Data

City	October		
	1951	1950	Normal
Abilene, Texas (A)	77	9	0
Albany, New York (A)	418	380	446
Albuquerque, New Mexico (A)	200	20	273
Alpena, Michigan (C)	513	413	570
Anaconda, Montana (C)	764	599	647
Asheville, North Carolina (C)	195	119	276
Atlanta, Georgia (C)	73	31	96
Atlantic City, New Jersey (C)	157	163	254
Augusta, Georgia (A)	37	20	16
Baker, Oregon (C)	597	434	552
Baltimore, Maryland (C)	148	147	223
Billings, Montana (A)	620	409	524
Binghamton, New York (C)	362	393	453
Birmingham, Alabama (A)	86	43	0
Bismarck, North Dakota (A)	680	496	626
Block Island, Rhode Island (A)	264	256	279
Boise, Idaho (A)	482	261	434
Boston, Massachusetts (A)	309	281	363
Bozeman, Montana (C)	727	568	651
Buffalo, New York (A)	348	324	419
Burlington, Iowa (A)	333	211	(a)
Burlington, Vermont (A)	459	445	481
Butte, Montana (C)	828	594	655
Cairo, Illinois (C)	155	59	158
Charleston, South Carolina (C)	17	3	0
Charlotte, North Carolina (C)	91	47	115
Chattanooga, Tennessee (A)	111	57	105
Cheyene, Wyoming (A)	650	375	605
Chicago, Illinois (C)	319	186	326
Cincinnati, Ohio (C)	191	110	254
Cleveland, Ohio (A)	265	246	366
Columbia, Missouri (A)	256	130	260
Columbia, South Carolina (C)	35	23	31
Columbus, Ohio (C)	248	175	313
Concord, New Hampshire (A)	465	439	484
Concordia, Kansas (C)	345	141	276
Dallas, Texas (A)	56	5	0
Davenport, Iowa (C)	327	185	363
Dayton, Ohio (A)	280	209	273
Deer Lodge, Montana (C)	720	629	733
Denver, Colorado (C)	513	159	428
Des Moines, Iowa (A)	403	204	357
Detroit, Michigan (A)	332	284	400
Devils Lake, North Dakota (C)	768	598	706
Dodge City, Kansas (A)	350	131	276
Dubuque, Iowa (C)	459	234	409
Duluth, Minnesota (C)	707	565	626
Eastport, Maine (A)	485	514	543
Elkins, West Virginia (A)	341	311	378
El Paso, Texas (A)	21	0	40
Ely, Nevada (A)	672	422	(a)
Erie, Pennsylvania (C)	272	241	378
Escanaba, Michigan (C)	586	464	591
Evansville, Indiana (A)	226	120	155
Fargo, North Dakota (A)	665	536	607
Fort Smith, Arkansas (A)	115	45	62
Fort Wayne, Indiana (A)	328	262	347
Fort Worth, Texas (A)	52	3	0
Fresno, California (A)	89	41	19
Galveston, Texas (C)	0	0	0
Grand Junction, Colorado (A)	383	129	369
Grand Rapids, Michigan (A)	371	328	419
Green Bay, Wisconsin (C)	533	426	505
Greensboro, North Carolina (A)	134	112	143
Greenville, South Carolina (A)	75	41	146
Harrisburg, Pennsylvania (A)	274	271	329
Hartford, Connecticut (A)	331	315	344
Hatteras, North Carolina (C)	16	6	0
Havre, Montana (C)	727	531	620
Helena, Montana (A)	730	528	614
Houston, Texas (C)	1	0	0
Huron, South Dakota (A)	580	396	526
Indianapolis, Indiana (A)	281	199	298
Jackson, Mississippi (A)	57	17	(a)
Kansas City, Missouri (A)	279	116	219
Knoxville, Tennessee (A)	145	70	183
La Crosse, Wisconsin (A)	445	330	462
Lander, Wyoming (A)	661	418	654

(a) Data not available.

City	October		
	1951	1950	Normal
Lansing, Michigan (A)	408	339	481
Lewiston, Maine (O)	465	480	501
Lincoln, Nebraska (C)	372	191	316
Little Rock, Arkansas (A)	120	38	47
Livingston, Montana (C)	703	474	523
Los Angeles, California (C)	14	2	0
Louisville, Kentucky (A)	224	115	186
Lynchburg, Virginia (A)	179	154	220
Macon, Georgia (A)	32	11	6
Madison, Wisconsin (C)	454	292	459
Marquette, Michigan (C)	597	476	567
Memphis, Tennessee (A)	134	48	62
Meridian, Mississippi (A)	67	25	22
Milwaukee, Wisconsin (A)	411	293	450
Minneapolis, Minnesota (A)	506	358	481
Moline, Illinois (A)	350	222	(a)
Montgomery, Alabama (A)	35	6	0
Nantucket, Massachusetts (A)	291	323	335
Nashville, Tennessee (A)	165	69	136
New Haven, Connecticut (A)	308	282	360
New Orleans, Louisiana (C)	7	0	0
New York, New York (C)	212	174	272
Nome, Alaska† (A)	(a)	613	744
Norfolk, Virginia (C)	63	47	99
North Head, Washington (C)	354	393	366
North Platte, Nebraska (A)	520	288	434
Oakland, California (C)	123	117	183
Oklahoma City, Oklahoma (C)	171	43	105
Omaha, Nebraska (A)	387	202	329
Oswego, New York (C)	355	357	459
Parkersburg, West Virginia (C)	248	172	285
Peoria, Illinois (A)	334	191	381
Philadelphia, Pennsylvania (C)	170	166	235
Phoenix, Arizona (C)	8	0	0
Pittsburgh, Pennsylvania (C)	220	204	313
Pocatello, Idaho (A)	586	386	499
Portland, Maine (A)	491	484	477
Portland, Oregon (C)	290	352	332
Providence, Rhode Island (C)	277	272	348
Pueblo, Colorado (A)	462	155	388
Raleigh, North Carolina (C)	86	61	130
Rapid City, South Dakota (A)	563	347	515
Reading, Pennsylvania (C)	228	230	344
Red Bluff, California (A)	78	96	(a)
Reno, Nevada (A)	558	355	453
Richmond, Virginia (C)	138	119	161
Rochester, New York (A)	365	349	431
Roswell, New Mexico (A)	112	36	186
Sacramento, California (C)	82	72	71
St. Joseph, Missouri (A)	328	148	248
St. Louis, Missouri (C)	211	102	205
Salt Lake City, Utah (A)	443	225	388
San Antonio, Texas (A)	2	0	0
San Diego, California (A)	17	5	34
Sandusky, Ohio (C)	255	216	353
San Francisco, California (C)	123	107	146
Sault Ste. Marie, Michigan (A)	615	534	623
Savannah, Georgia (A)	19	6	0
Scranton, Pennsylvania (C)	334	298	397
Seattle, Washington (C)	346	281	394
Sheridan, Wyoming (A)	646	403	636
Shreveport, Louisiana (A)	39	10	0
Sioux City, Iowa (A)	457	288	415
Spokane, Washington (A)	591	561	515
Springfield, Illinois (C)	260	133	282
Springfield, Missouri (A)	254	120	217
Syracuse, New York (A)	377	357	425
Tacoma, Washington (C)	401	418	400
Terre Haute, Indiana (A)	274	183	233
Toledo, Ohio (A)	325	281	369
Topeka, Kansas (C)	308	109	236
Trenton, New Jersey (C)	232	224	242
Utica, New York (O)	390	388	430
Valentine, Nebraska (C)	544	329	490
Walla Walla, Washington (C)	372	334	332
Washington, D. C. (C)	152	149	251
Wichita, Kansas (A)	293	99	192
Williston, North Dakota (C)	695	555	660
Winnemucca, Nevada (C)	593	395	507
Yakima, Washington (A)	515	520	437

(a) Data not available. †Nome data are for September.

Figures in this table, with seven exceptions, based on local weather bureau reports. Exceptions are Utica and Lewiston, figures for which are furnished through the courtesy of Coke Sales Department, Central New York Power Corp., Utica, N. Y., and Norman E. Ross, Bursar, Bates College, Lewiston, Me., respectively; Anaconda, Bozeman, Butte, Deer Lodge and Livingston, Mont., through the courtesy of the Montana Power Company.

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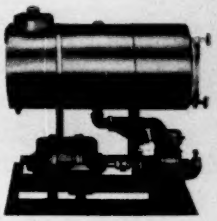

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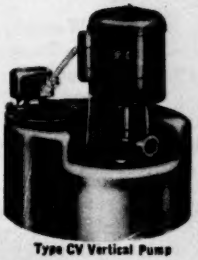
Type TM High Pressure Turbine Pump. Designed for pressures up to 150 pounds and boilers to 250 H.P.



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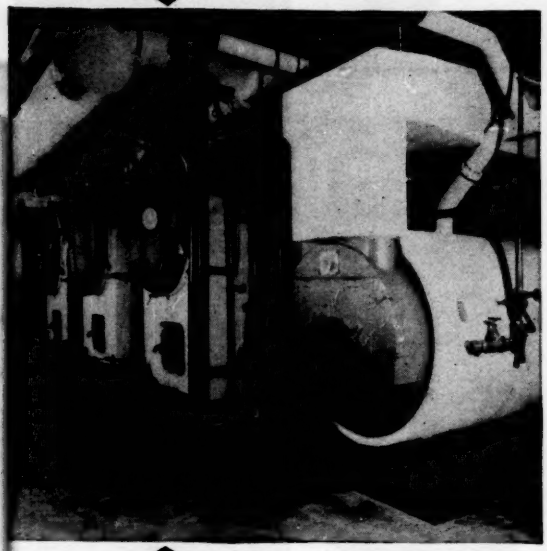

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ABSTRACTS AND REVIEWS

Publications abstracted in this department should be ordered direct from publisher.

HEATING DESIGN AND PRACTICE

Both the engineer and the student interested in heating should find much of value in Heating Design and Practice by Robert Henderson Emerick, consulting engineer, Charleston, S. C.

The author has attempted to bring together practical information on subjects and problems concerning heating or closely related to heating—such as fuels and fuel handling, fireplaces and chimneys. Data presented are of a practical, useable nature and there is an absence of mathematical formulas and their derivations. Not only does this book cover hot water and steam heating, but there are chapters on warm air heating, the heat pump, and district steam heating.

The information is arranged in 21 chapters some of which are: How heating loads are calculated; designing a steam heating system; heating boilers and steam generators; designing a hot water heating system; boiler firing equipment; water heaters and how to size them; designing a warm air heating system; panels, baseboards, and unit heaters; fans and filters; space heaters; district steam heating; the heat pump, fuels and fuel handling; chimneys, stacks and flues; heat insulation and refractories; fireplace design and performance; how to choose a heating system; incinerators and destructors; specifications and the analysis of bids.

Heating Design and Practice, by R. H. Emerick. Cloth bound, 6 x 9 inches, 453 pages. Published by McGraw-Hill Book Co., 330 W. 42nd St., New York 18, N. Y. Price, $8.

• • •

OVERFIRE JETS TO PREVENT SMOKE FROM STATIONARY PLANTS—As an aid to coal users, Bituminous Coal Research, Inc., has started a new series of publications to be known as BCR Aids to Industry. The first one to be issued is BCR Aid to Industry 500-300 on Application of Overfire Jets to Abate Smoke from Stationary Plants. It is a 24-page booklet complete with sketches, charts and tables. Bituminous Coal Research, Inc., 2609 First National Bank Bldg., Pittsburgh 22, Pa. Price, 50 cents.

COAL AND COKE TESTS EVALUATED—Information Circular 7610, Significance of Laboratory Tests of Coal for Combustion, presents the opinions of a chosen group of expert fuel engineers. This information covers the value, from the standpoint of practical fuel use, of the American Society for Testing Materials laboratory tests on coal and coke, and how the results can be applied. Bureau of Mines, Publications Distribution Section, 4800 Forbes St., Pittsburgh 13, Pa.

RADIANT BASEBOARD HEATING—A study was conducted at the Engineering Experiment Station, University of Illinois to determine the effect of reduced thermostat setting and open bedroom windows at night on radiant base-

board heating. The findings are available in a 67-page booklet—Bulletin Series No. 391. It is the seventh in a series of bulletins detailing the results of a cooperative research program carried on at the Experiment Station in cooperation with the Institute of Boiler and Radiator Manufacturers. One of the interesting findings of this study is that from the standpoint of uniform room air temperature, short and frequent cycles of operation are preferable to longer, less frequent cycles. The Engineering Experiment Station, University of Illinois, Urbana, Illinois. Price, 70 cents.

LOCATING WARM AIR OUTLETS—As part of a series of questions and answers on warm air heating, the National Warm Air Heating & Air Conditioning Association has issued a 4-page folder dealing with Locating Warm Air Outlets in Non-Residential Buildings. Step by step procedure is given for the design for the store building which is taken as the special problem. Folder contains helpful design data. National Warm Air Heating and Air Conditioning Association, 145 Public Square, Cleveland 14, Ohio.

PREDETERMINING NATURAL VENTILATION—A special research report on the feasibility of using models for predetermining natural ventilation was prepared by Elmer G. Smith, Research Physicist of the Texas Engineering Experiment Station. While the advantage of utilizing the natural wind to ventilate buildings has long been recognized, little work had been done to establish methods for predetermining a natural flow pattern for ventilating enclosed buildings. This investigation study covers ventilation of buildings of moderate ceiling height so that effects of moderate thermal convection are negligible. For a copy of this Research Report No. 26, write Texas Engineering Experiment Station, The Texas A & M College System, College Station, Texas.

GETTING PERSONAL

W. A. Bingham

W. A. Bingham (*Unusual Refrigeration System for Low Temperature Test Chambers*, page 69) attended the University of Tampa, Fla. He has had 14 years experience in refrigeration, construction and service work.

He has been with Carrier Corp. for five years, at first assigned to the Construction and Service Departments in the Atlanta, Ga. district. Later he was transferred to the Cleveland, Ohio district to take over operational con-

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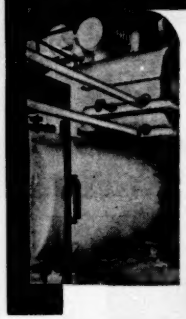

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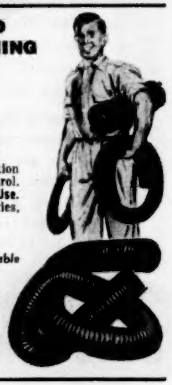

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tract environmental test facilities at Wright-Patterson Air Force Base, Dayton, Ohio. At present Mr. Bingham is at the home office, Syracuse, N. Y. Among his duties, he is conducting a class for control engineers.

R. B. Conlan

Richard B. Conlan (*Correcting the Iron Problem in Water Systems*, page 77) is a chemical engineer specializing in industrial water conditioning. Mr. Conlan attended St. Joseph's College and Drexel Institute of Technology. After association with the Barrett Division, Allied Chemical and Dye Corporation, Mr. Conlan joined the engineering staff of W. H. & L. D. Betz, Philadelphia, Pa., and has been with that organization since 1943. He is the author of numerous technical publications in the water conditioning field.

R. K. Demarest, Jr.

Robert K. Demarest, Jr. (*Pipe Required for Radiant Heat Coils*, page 101) is currently employed as a mechanical engineer by William G. Lyles, Bissett, Carlisle and Wolff, architects and engineers of Columbia, S. C. He is a graduate of mechanical engineering of The Georgia Institute of Technology, having received his degree a year ago. During World War II he served as a corporal in the U. S. Marine Corps and participated in the capture of Iwo Jima. Prior to the war, he had several years' experience in naval architecture and marine engineering.

E. M. Tarnoff

Edwin M. Tarnoff (*Effectiveness of Fire Tube Inserts in Boilers and Furnaces*, page 83) is manager of the Thermobloc Division of Prat-Daniel Corp., South Norwalk, Conn. He directed the development work in establishing the line of Thermobloc space heating equipment in the United States and has been associated with the Thermobloc Division since its inception. He was graduated from the University of Michigan College of Engineering, Ann Arbor, Michigan.

Prior to joining the Prat-Daniel Corp., Mr. Tarnoff was with the Engineering Department of E. I. duPont deNemours and Co., working on the development of new operations.

Mr. Tarnoff is a member of ASHVE, and is a licensed engineer in the State of Connecticut.

He is the author of several articles on industrial heating, as well as process applications of direct-fired heating equipment.

Canadian Degree-Days for September and October, 1951*

City	September		October	
	1951	Normal	1951	Normal
Calgary, Alta.	539	432	1014	722
Charlottetown, P. E. I	210	222	536	761
Crescent Valley, B. C.	380	360	676	698
Edmonton, Alta.	515	444	994	747
Fort William, Ont.	453	354	775	722
Grande Prairie, Alta.	513	480	1045	812
Halifax, N. S.	130	189	441	499
London, Ont.	213	126	446	508
Medicine Hat, Alta.	416	834	267	868
Moncton, N. B.	240	282	583	595
Montreal, P. Q.	210	180	502	561
North Bay, Ont.	382	264	670	694
Ottawa, Ont.	252	204	540	595
Penticton, B. C.	202	213	546	527
Porquis Junction, Ont.	489	396	834	800
Prince George, B. C.	513	444	918	741
Quebec City, P. Q.	249	276	564	651
Regina, Sask.	463	408	876	794
St. John, N. B.	201	270	484	558
Saskatoon, Sask.	474	396	973	781
Toronto, Ont.	141	168	409	504
Vancouver, B. C.	202	234	477	459
Victoria, B. C.	253	264	463	446
Windsor, Ont.	138	54	341	425
Winnipeg, Man.	390	330	797	744

*These data are supplied through the courtesy of the Meteorological Division, Air Service Branch, Department of Transport, Canada.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, AND CIRCULATION REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933, AND JULY 2, 1946 (Title 39, United States Code, Section 233) OF "HEATING AND VENTILATING" published monthly at New York, N. Y., for Oct. 1, 1951.

1. The names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher, The Industrial Press, 148 Lafayette St., New York 13, N. Y.

Editor, Clifford Strock, 148 Lafayette St., New York 13, N. Y.

Managing Editor, none.

Business Managers, Robert B. Luchars, 148 Lafayette St., New York 13, N. Y.; Edgar A. Becker, 148 Lafayette St., New York 13, N. Y.; Harold L. Gray, 148 Lafayette St., New York 13, N. Y.

2. The owner is:

The Industrial Press, 148 Lafayette St., New York 13, N. Y.; Robert B. Luchars, 148 Lafayette St., New York 13, N. Y.; Edgar A. Becker, 148 Lafayette St., New York 13, N. Y.; Franklin D. Jones, 148 Lafayette St., New York 13, N. Y.; Walter E. Robinson, 148 Lafayette St., New York 13, N. Y.; Charles O. Herb, 148 Lafayette St., New York 13, N. Y.; Harold L. Gray, 148 Lafayette St., New York 13, N. Y.; Clifford Strock, 148 Lafayette St., New York 13, N. Y.; Suno E. Larson, 148 Lafayette St., New York 13, N. Y.; Helena E. Oberg, 65-82 St., Brooklyn 9, N. Y.; Wilbert A. Mitchell, 28 Harlow Road, Springfield, Vt.; First National Bank & Trust Co. of Montclair & Robert B. Luchars, Trustees (Beneficiaries Unknown). Upper Montclair, N. J.; First National Bank & Trust Co. of Montclair & Leigh Roy Urban, Trustees (Beneficiaries Unknown), Upper Montclair, N. J.; First National Bank & Trust Co. of Montclair & Kenneth D. Ketchum, Trustees (Beneficiaries Unknown), Upper Montclair, N. J.; Lee W. Urban, Guardian for Susan Yarnall Urban, 27 Clinton St., Oneonta, N. Y.; Lee W. Urban, Executrix of Will of Robert L. Urban, 27 Clinton St., Oneonta, N. Y.; John T. Urban, 224 Sullivan St., New York 12, N. Y.

3. The known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages, or other securities are:

Charlotte B. Baldwin, 420 Clinton Ave., Brooklyn, N. Y.; Franklin D. Jones, 148 Lafayette St., New York 13, N. Y.; Robert B. Luchars, 148 Lafayette St., New York 13, N. Y.; Louis Pelletier, 148 Lafayette St., New York 13, N. Y.; Elizabeth Y. Urban, 38 Lakeview Road, Asheville, N. C.; Helen L. Ketchum, 231 King Street, Cohasset, Mass.; Wilbert A. Mitchell, 28 Harlow Road, Springfield, Vt.; Henry V. Oberg, 3375 Kenmore Road, Shaker Heights 22, Ohio.

4. Paragraphs 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

EDGAR A. BECKER, Business Manager

Sworn to and subscribed before me this 28th day of September, 1951.

CHARLES P. ABEL,

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COMING EVENTS

Where listed, names or titles of individuals are those from whom further information is available.

WARM AIR CONVENTION—38th annual convention of the National Warm Air Heating and Air Conditioning Association, at Hotel Cleveland, Cleveland, Ohio. George Boeddener, 145 Public Square, Cleveland. . . . . **DECEMBER 5-6, 1951.**

PLANT MAINTENANCE SHOW AND CONFERENCE — 3rd plant maintenance show and conference, at Convention Hall, Philadelphia, Pa. Clapp & Poliak, Inc., 341 Madison Ave., New York 17, N. Y. . . . . **JANUARY 14-17, 1952.**

AUTOMOTIVE ENGINEERS MEETING — Annual meeting of the Society of Automotive Engineer, Inc., at the Hotel Book-Cadillac, Detroit, Mich. John A. C. Warner, secretary of the Society, 29 West 39th St., New York 18, N. Y. **JANUARY 14-18, 1952.**

ELECTRIC ENGINEERING MEETING—Winter general meeting of the American Institute of Electrical Engineers, at the Hotel Statler New York, N. Y. Secretary of the Institute, 33 West 39th St., New York 18, N. Y. . . . . **JANUARY 21-25, 1952.**

ASHVE MEETING—58th annual meeting of the American Society of Heating and Ventilating Engineers, in St. Louis, Mo. A. V. Hutchinson, secretary of the Society, 62 Worth St., New York, N. Y. (Next International Heating, Ventilating and Air Conditioning Exposition to be held in conjunction with the society's 59th annual meeting, January, 1953, in Chicago.) **JANUARY 28-30, 1952.**

CORROSION ENGINEERS EXHIBIT—Annual conference and exhibition of the National Association of Corrosion Engineers, at Municipal Pier and Galvez Hotel, Galveston, Tex. Executive secretary, 905 Southern Standard Building, Houston 2, Tex. **FEBRUARY 11-14, 1952.**

ASME MEETING—Spring meeting of the American Society of Mechanical Engineers, at the University of Washington, Seattle, Wash. C. E. Davies, secretary of the Society, 29 West 39th St., New York, N. Y. . . . . **MARCH 24-26,1952.**

OIL HEAT EXPOSITION—National Oil Heat Exposition, at Commercial Museum, Philadelphia, Pa., in conjunction with the 29th annual convention of Oil-Heat Institute of America, at the Benjamin Franklin Hotel. R. H. L. Becker, secretary of the Institute, 6 East 39th St., New York 16, N. Y. **APRIL 14-18, 1952.**

GAS APPLIANCE MEETING—Annual meeting of the Gas Appliance Manufacturers Association at The Broadmoor, Colorado Springs, Colo. H. Leigh Whitelaw, managing director of the Association, 60 E. 42nd St., New York, N. Y. **APRIL 21-23, 1952.**

NDHA MEETING—Annual meeting of the National District Heating Association at Skytop Lodge, Skytop, Pa. John F. Collins, secretary of the Association, 827 N. Euclid Ave., Pittsburgh 6, Pa. . . . . **JUNE 3-6, 1952.**

ASME MEETING — Semi-annual meeting of the American Society of Mechanical Engineers, at the Sheraton Gibson Hotel, Cincinnati, Ohio. C. E. Davies, secretary of the Society, 29 West 39th St., New York, N. Y. . . . . **JUNE 15-19, 1952**

TESTING MATERIALS MEETING—Annual meeting of the American Society for Testing Materials at the Hotel Statler, New York, N. Y. Secretary of the Society, 1916 Race St., Philadelphia 3, Pa. . . . . **JUNE 23-27, 1952.**

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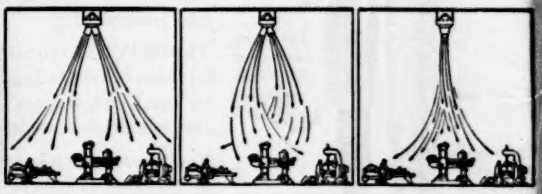

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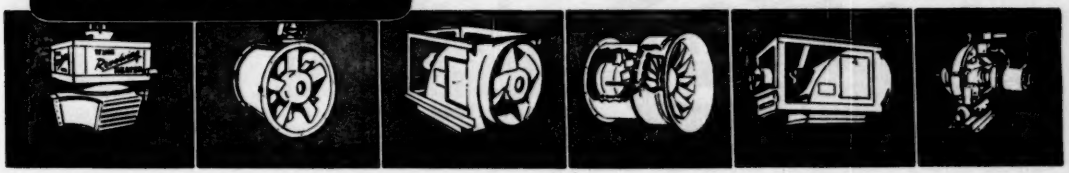

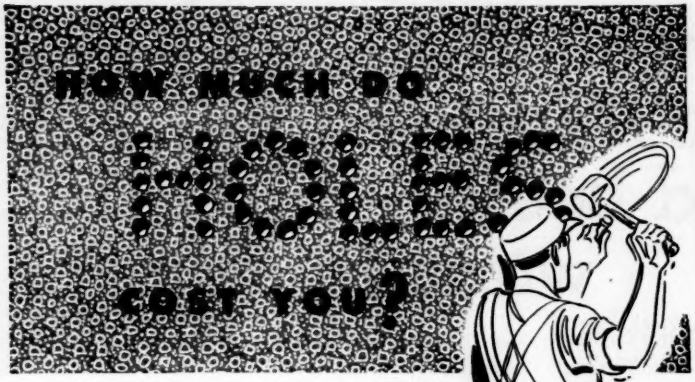

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Tube Sizes—Seamless drawn Monel, *A* nickel, and low carbon nickel are produced in outside diameters from ⅛ inch O.D. to 8¼ inches by 1/16 inch increments from ⅛ to 2 inch O.D.; by ⅛ inch increments from 2 to 5 inch O.D.; by ¼ inch increments from 5 to 8¼ inch O.D.

Seamless drawn Inconel tube is produced from ⅛ to 6 inch O.D. by 1/16 inch increments from ⅛ to 1½ inch O.D.; by ⅛ inch increments from 1½ to 5 inch O.D.; and ¼ inch increments from 5 to 6 inch O.D.

Seamless drawn *K* Monel is produced from ⅛ to 8¼ inch O.D. in 1/16 inch increments from ⅛ to 1½ inch O.D.; and ⅛ inch increments from 1½ to 8¼ inch O.D.

Tube walls are drawn to Stub's gage wall thicknesses from 0.035 to 0.312 inch for Monel *A* nickel, and low carbon nickel; 0.065 to 0.312 for *K* Monel; and 0.035 to 0.259 for Inconel. All Stub's gages are available in tubes over 1 inch to 8 inches in diameter, inclusive, for Monel *A* nickel, and low carbon nickel. All Stub's gages are available in Inconel above ⅜ inch to 8 inches diameter, inclusive.

Note: Not all the lighter gages are available in tubes above 3 inches, nor are all the heavier gages available in tubes 1 inch diameter and under.

Tube Lengths—Seamless Monel, *A* nickel, and low carbon nickel tube are produced in random mill lengths of 5 to 24 ft, with maximum cut lengths up to 40 ft in all tempers, and 65 ft cut length only in the annealed temper.

Seamless *K* Monel tube is available in random mill lengths of 5 to 20 ft and with maximum cut lengths of 20 ft.

Inconel seamless tube is produced in random mill lengths of 5 to 20 ft, with maximum cut lengths of 20 ft; longer lengths, in some sizes available in standard 20 ft cut lengths, can be produced longer than 20 ft, not pickled, for certain heat-treating applications.

Pipe Sizes and Lengths—Monel, *A* nickel and low carbon nickel are available in pipe sizes from ⅛ to 6 inch diameter (IPS Schedule 10); in standard iron pipe sizes (Schedule 40) from ⅛ to 8 inch diameter; in extra-heavy iron pipe sizes (Schedule 80) from ⅛ to 8 inch diameter.

Inconel seamless pipe is produced in standard sizes ⅛ to 4 inches (IPS Schedule 10), ⅛ to 6 inch for standard iron pipe sizes (Schedule 40), and ⅛ to 4 inch diameter for extra-heavy iron pipe sizes (Schedule 80).

Monel, *A* nickel, low carbon nickel, *K* Monel, and Inconel are available in maximum pipe lengths, depending on size, as follows: Schedule 10, 20-50 ft; Schedule 40, 14-60 ft; Schedule 80, 6-65 ft.

Small-size Seamless Tube—Monel, *K* Monel, *A* nickel, low carbon nickel, and Inconel seamless tube is redrawn to small sizes and wall thicknesses by producers specializing in small tube. Generally, the size range for small tube made of these materials will be from 0.012 to 0.625 inch O.D., with a minimum wall thickness of 0.0015 inch in the small size to 0.010 inch in the larger sizes. The maximum wall thickness is 0.035 inch for the smallest size to 0.120 inch for the largest size of this size range.

Welded, and Welded and Drawn Tube

Welded Tubing—Welded Monel and Inconel tube is formed and welded (atomic hydrogen or inert arc methods) together strip, in available from ⅛ to 2 inches diameter for wall thickness from 0.022

TABLE 1. PHYSICAL CONSTANTS OF NICKEL ALLOYS.

	Monel[a]	"K" Monel	"A" Nickel	Low Carbon Nickel	Inconel[a]
Density, lb./cu. in.	0.319	0.306	0.321	0.321	0.307
Melting Range, °F.	2370-2460	2460-2460	2615-2635	2615-2635	2540-2600
Mean Specific Heat, Btu./lb./°F. or cal./gm./°C.	0.127[b]	0.127[b]	0.113[b]	0.113[b]	0.107[b]
Mean Coefficient of Thermal Expansion, in./in. °F.	0.0000076[c]	0.0000076[d]	0.0000072[e]	0.0000072[e]	0.0000069[c]
Thermal Conductivity, Btu./sq. ft./hr./°F./in.	169[b]	128[b]	420[b]	420[b]	104[b]
Modulus of Elasticity in Tension, psi.	26,000,000	26,000,000	30,000,000	30,000,000	31,000,000
Modulus of Elasticity in Torsion, psi.	9,500,000	9,500,000	11,000,000	11,000,000	11,000,000
Poisson's Ratio	0.32	0.32	0.31	0.31	0.29

(a) 200° F.
(b) 80-212° F.
(c) 77-212° F.
(d) 70-212° F.
(e) 32-212° F.
* Eng. U.S. Fps. cst.

TABLE 2—RANGE OF MECHANICAL PROPERTIES OF SEAMLESS NICKEL TUBING—⅛-Inch O. D. and Larger.

Material and Condition	Tensile Strength, 1000 psi	Yield Strength (0.2% offset), 1000 psi	Elongation, % in 2 in. per cent	Rockwell Hardness
NICKEL AND NICKEL ALLOY				
Nickel				
Annealed	70-85	25-45	35-55	75 B max.
Cold Drawn Annealed	85-110	45-100	25-45	65-90 B
Cold Drawn Stress Relieved	85-120	65-105	25-40	80 B-30 C
"K" Monel				
Annealed	90-110	40-65	40-55	85 B max.
Cold Drawn, Age Hardened	120-160	85-110	20-30	25-35 C
As Drawn	110-140	85-120	15-25	95 B-35 C
As Drawn, Age Hardened	145-185	100-160	10-20	97 C-45 C
"S" Monel				
Annealed	75-95	35-50	35-45	75 B max.
Cold Drawn, Stress Relieved	95-120	80-105	20-30	25-35 C
Cold Drawn, Annealed	80-105	35-70	35-45	70-90 B
Low Carbon Nickel				
Annealed	55-70	15-30	50-60	45 B max.
Cold Drawn Stress Relieved	65-100	35-80	25-45	75-95 B
Inconel				
Annealed	80-100	30-60	35-55	85 B max.
INCONEL "X" AND EVAPORATOR TUBING				
Inconel				
Annealed	85-95	35-50	35-45	75 B max.
Cold Drawn Stress Relieved	95-120	80-95	25-35	25-35 C
"A" Nickel				
Annealed	55-70	15-30	50-60	45 B max.
Cold Drawn Stress Relieved	65-95	45-75	25-35	75-95 B
Low Carbon Nickel				
Annealed	55-70	15-30	50-60	45 B max.
Cold Drawn Stress Relieved	65-95	35-75	25-35	75-95 B
Inconel				
Annealed	80-100	30-60	35-55	85 B max.

to 0.035 inch. Monel welded tube can be produced in smaller sizes down to 0.012 inch O.D., having a maximum wall of 0.005 or a minimum wall thickness of 0.0015 inch. These small sizes are secured by redrawing the welded tube. Thin-wall welded tube is also made in diameters up to 1¾ inches and wall thicknesses from 0.010 to 0.035 inch.

Various fabricators produce welded tube (large diameter, over 2 inch O.D.) in heavy and thin walls with practically no upper limit to diameter for such custom-made tube.

Extruded Tube—Monel, *K* Monel, *A* nickel, low carbon nickel, and Inconel tube is produced as extruded tube in certain size ranges and wall thicknesses. In general, the commercial size range for extruded tube is as follows: Monel, 3¼ to 9⅝ inches, inclusive; *K* Monel, 3½ to 6 inches, inclusive; *A* nickel and low carbon nickel, 3½ to 9⅝ inches, inclusive; Inconel, 3¼ to 6 inches, inclusive. These sizes are available in most wall thicknesses from ⅛ to ⅝ inch thick by 1/16 inch increments. Heavier walls and other intermediate sizes can possibly be made requiring special set-up and tooling.

TABLE 3. CONVERSION FACTORS FOR NICKEL TUBE WEIGHT.

(Multiply steel pipe weights by factor below)

Iron Alloy	Conversion Factor
Monel	1.122
K Monel	1.078
A nickel	1.130
Low carbon nickel	1.130
Inconel	1.061

Only two tempers are available: (1) as-extruded, (2) annealed. Both the extruded and annealed extruded tubes will possess a rough surface having a dark to gray oxide matte coating. Extruded tube is suitable where cold-drawn finish and tolerances are not required. If a smooth, concentric surface is required, machining is then necessary for both straightness and surface quality.

Weights—Theoretical weights of nickel and nickel alloy tubes may be calculated by referring to the published tables of carbon steel tubular weights. Multiply the steel weights by the factors in Table 3 for the iron alloy required.

Thermal Cutting

Neither nickel, Monel or Inconel can be cut with conventional oxy-acetylene equipment. Mechanical separation with saws or friction wheels is preferred. The Powder Cutting[1] or Oxy-Arc[2] processes may be used, but all slag, burned material, or spatter resulting from the use of these processes must be removed prior to welding.

Silver Brazing

Silver brazing is useful for joining all sizes of pipe and tube where the corrosive environment and service temperature will permit the use of a silver-brazing alloy. The strength of silver-brazed joints in nickel and high-nickel alloys drops off sharply above 450F.

Lap or socket-type joints are recommended, and the amount of lap should be at least 2 to 5 times the wall thickness of the thinnest member. The fit of parts is important, and the clearance, for the brazing alloy to flow through, should be held to a minimum. When radial clearances over 0.005 inch to 0.006 inch are permitted, the strength of the joint will only be that of the brazing alloy, or approximately 50,000 lb per sq in. Maximum joint strengths are obtained with approximately 0.002 inch radial clearance, but clearances of this order are rather difficult to obtain in production in pipe and tubing joints.

[1]Linde Air Products Company—patented process.
[2]Arcos Corporation—patented process.

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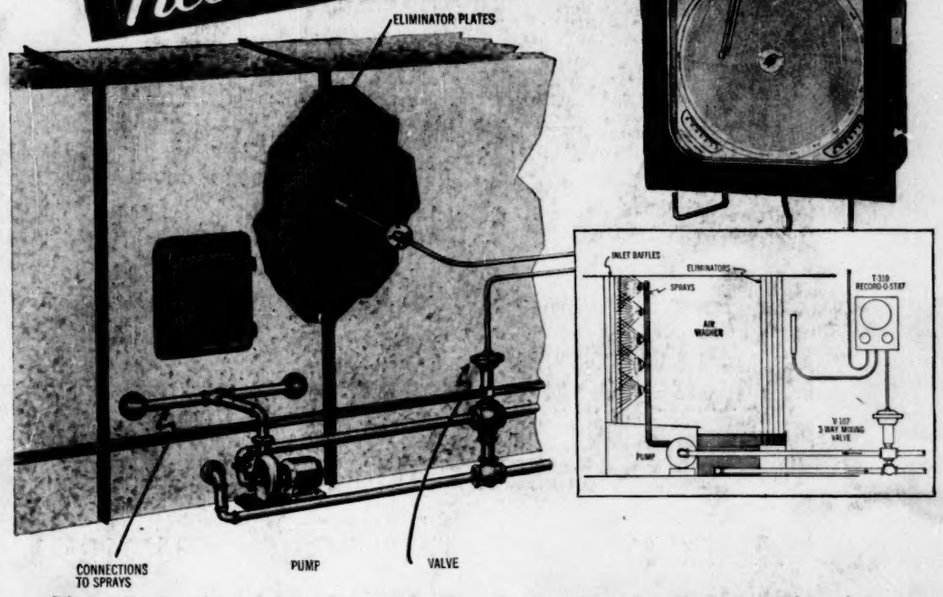

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